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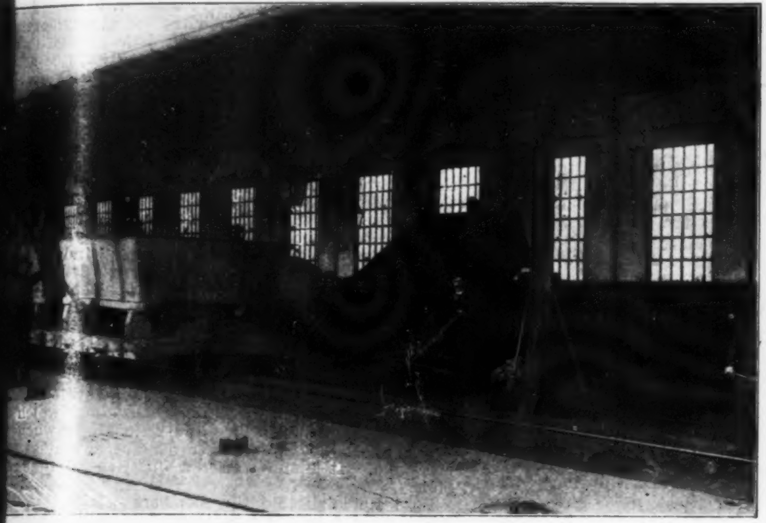


FIG. 1.—SIDE-DUMPING COKE-CAR.

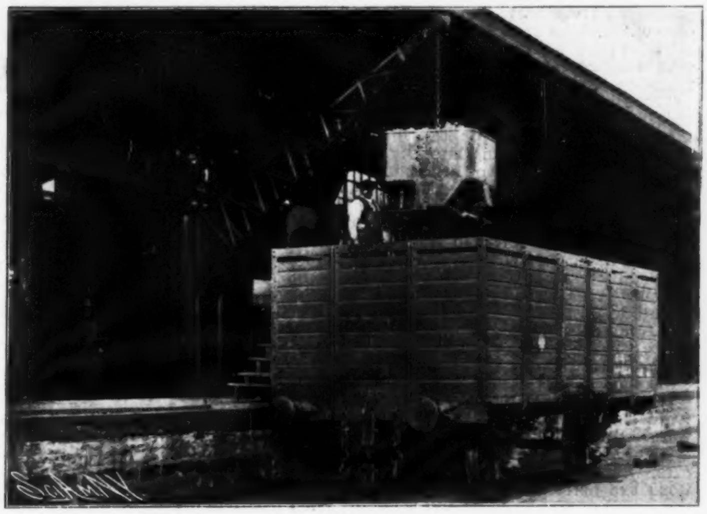


FIG. 2.—CRANE AND THREE-WHEELED BUCKET FOR LOADING COKE-CARS.

FIG. 3.—APPARATUS FOR MEASURING COKE AND FILLING SACKS.

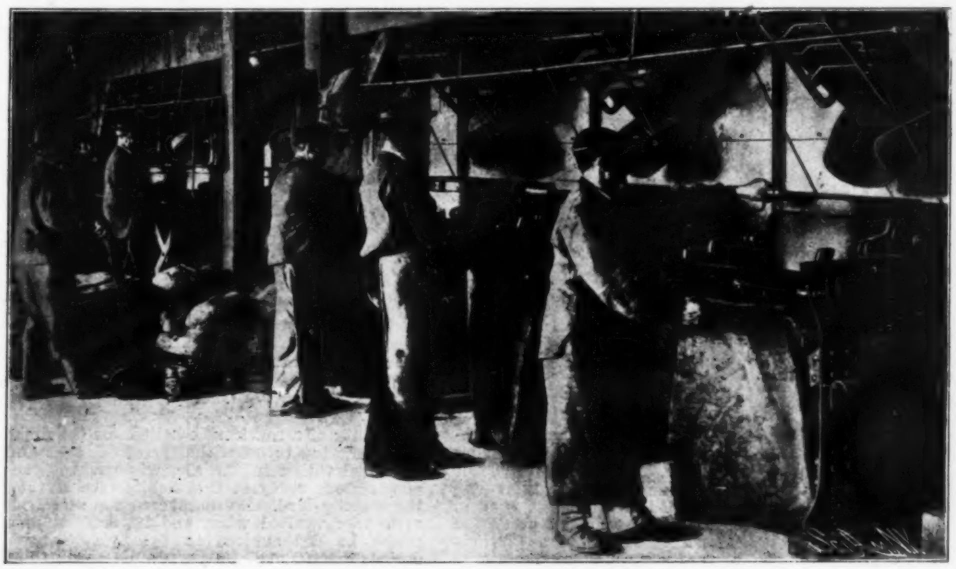


FIG. 4.—MEASURING AND SACKING THE COKE.

IG. 5.—TWO-PLATFORM MACHINE FOR LIFTING A BAG TO A PORTER'S BACK.

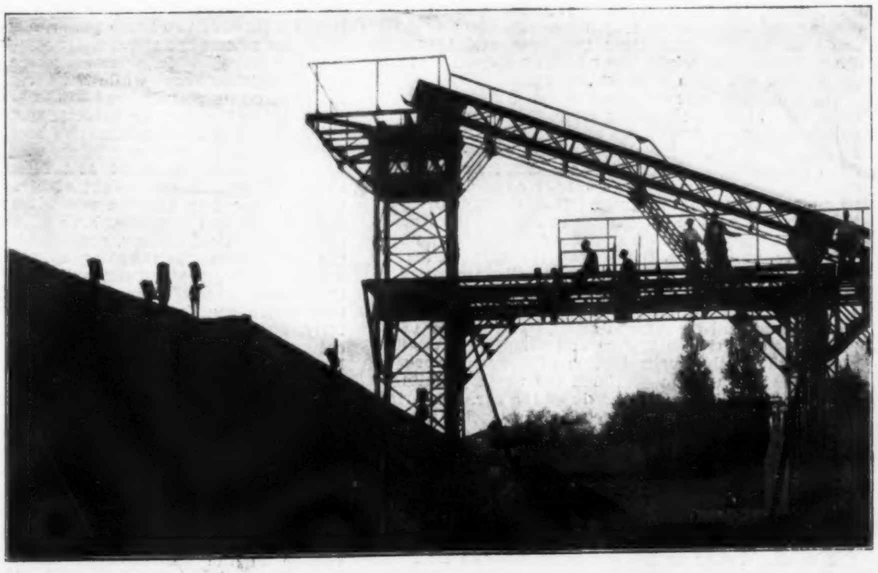


FIG. 6.—THE OLD SYSTEM OF HANDLING COKE, EMPLOYED DURING INSTALLATION OF THE NEW APPARATUS.

THE MECHANICAL CONVEYING OF COAL AND COKE.—I.

THE MECHANICAL CONVEYING OF COAL AND COKE.*—I.

Specially Prepared for the SCIENTIFIC AMERICAN SUPPLEMENT by EMILE GUARINI.

THE Paris Gas Company has installed in its numerous works a mechanical equipment for the carriage of coal, and especially of coke, that may be considered as a model of its kind. This installation aims at a more vigorous, more rapid, and more economical exploitation, and one that is less fatiguing to the employes. It is justified, moreover, by the great importance of the different works of the company. Thus, at the Landy works, the supply of coal amounts annually to 150,000 tons, and the surface covered by the coal yards is upward of 1,021,250 square feet. As for the annual production of coke, that exceeds 52,000,000 cubic feet for the works as a whole. The installations were designed and carried out according to the plans of M. L. Bertrand, assistant engineer of the gas company, under the direction of M. Gigot, chief engineer of this service, and particularly of M. Louvel, chief engineer of the service of studies and works. They cost one million francs ($200,000).

Fig. 7 shows diagrammatically how the coal and coke are handled from the time they are unloaded from the barge to the end of the gas-making process.

The coal, brought to the works by rail or water, is unloaded by means of cranes, and then conveyed to the discharge hoppers or the bins either indirectly by means of cars opening laterally or at the bottom, or directly by means of the cars of the railway company.

The coal that has been classified in heaps is put into bins by means of special cars and then distributed in front of the furnaces. It is emptied into the cars from the hoppers through a chute provided with a movable gate. After it has been distilled, it is carried in metallic cars to the coke yards. Here the coke is shoveled into dump carts that work automatically, or into cars that take it to the crushers. Upon emerging from these apparatus, it is received in sacks or skips. The sacks are delivered in the city or taken to the heap. The skips serve for the loading of cars on the track.

Formerly, conveying was effected by means of iron-plate skips, crates, or sacks. The crates and sacks were carried on the backs of men.

At present, with the exception of the loading of the cars, which is done by means of skips, all the operations are performed mechanically with sacks having a capacity of 3.5 cubic feet and weighing filled from 115 to 120 pounds. This method of operation presents numerous advantages. As the overload of the conveyors is but about 3 pounds to the running foot, it has been possible to employ girders of wide reach, without too great expense, and to place their bearing points outside of the coal pile. Moreover, the use of sacks permits the use of the monorail, the light supports of which are easily carried on the backs of men.

The use of dynamo-electric apparatus has permitted of arranging at isolated points of the yards various tools which can be started and stopped instantaneously. In the cars for conveying the coke (Fig. 1) one of the sides is formed of a door with lugs, and this, when lowered, serves as a chute between the bottom and the hopper. A lever, formed of two sections connected by a hinge, serves for raising first the car and then the door. This arrangement enables one man to open and close the door, and prevents the accidents that might occur as a consequence of its too sudden fall upon a workman.

The automatic cart employed is based upon the principle that in a cart passing from the normal to the dumping position, the shafts undergo but a very slight displacement, while the distance that separates them from the center of the front of the cart increases considerably. In order that the energy expended in getting under way shall be greater than that required by the lifting, a rut has been formed in which the wheels engage at the moment of unloading. Therefore, when the horse pulls upon the shafts, the cart begins to rise, putting the tail in a position for the road, and it is not till then that it leaves the rut.

As already stated, the loading of the cars is done by means of special cranes and skips. The cranes (Fig. 2) are of the friction system and comprise a vertical pivot held on the vertical posts of the woodwork of the shed, and a boom of which the reach permits of bringing the skips into the axis of the car. Lowering is effected by means of a screw with so feeble a pitch that it cannot revolve under the action of the weight of the skip alone. The skips have a capacity of 35 cubic feet and open at the bottom for the discharge. They are mounted upon three wheels, two rear ones of which revolve around a stationary axle, while the third serves for steering. The wheels are placed upon a circle of which the center corresponds to that of the skips. Owing to this arrangement, one man can handle the skip, the weight of which, when loaded, is 1,628 pounds. The bottom is opened by means of a handle. Along with these skips there are employed others called "oscillating skips." These are carried by two wheels and are provided with two rollers. When they are filled, the center of gravity is situated below the axles, and they therefore turn upside down, without any trouble, over the aperture into which it is desired to discharge them. When empty, their center of gravity is below the axles, so that they right themselves spontaneously.

The measuring and sacking is done by means of the apparatus shown in Fig. 3. This is placed under the chute of the crushers (Fig. 4) and permits of filling the bags without effort and with the use of but one hand. To each apparatus a hopper is attached to which the bag is hooked. When the apparatus is placed under the chute of the crushers, the opening and closing of the latter are controlled by the motion of the hectoliter measure itself, by means of small chains that lower the gate of the chutes, as soon as the measure leaves the filling position, and open the chutes in the contrary case.

In proximity to the crushers or to the place where the bags are stored are established lifting apparatus for placing the bags on a man's back (Fig. 5). The platforms, two or four in each apparatus, have a reciprocating motion, with a momentary stoppage at the ends of their travel. The porter places the bag upon the platform when the latter is at the level of the ground, and takes it upon his back when the platform reaches the end of its upward travel, that is to say, at a height of 4½ feet. The framework of the lift is formed of [irons that serve as guides and roll-ways to four small wheels fixed to the platforms.

(To be continued.)

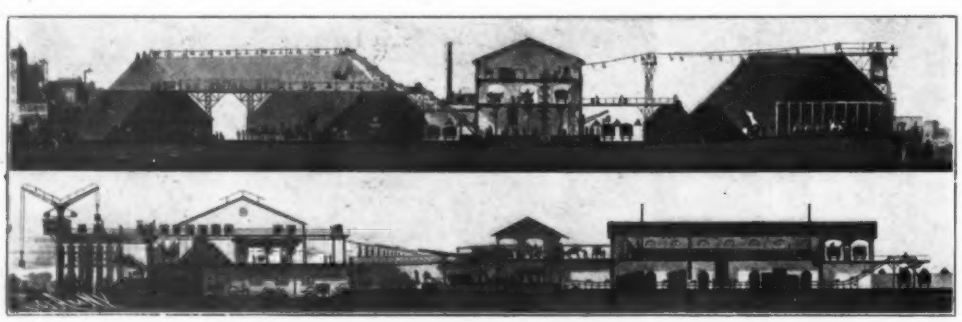


FIG. 7.—DIAGRAM SHOWING METHOD OF MECHANICALLY HANDLING COAL AND COKE.

THE MECHANICAL CONVEYING OF COAL AND COKE.

* The method of handling coal and coke here described seems distinctly inferior to the American system; still, the method is not without merit and is worth while presenting to readers of the SUPPLEMENT.—ED.

THE FLYING MACHINE AND ITS SLOW DEVELOPMENT.

THERE have been many propositions for fitting wings to man to enable him to fly or soar like a bird, the earliest appearing in France about 1660. Then a tight-rope performer, named Allard, made a few short flights; but his performances ended after he had a bad fall while exhibiting before King Louis XIV. The last of the experimenters in this branch of aerostation was Lilienthal, who was killed during a trial of his "wings" in Berlin in 1896.

LILIENTHAL'S WING THEORY.

Lilienthal, while not the first to point out the impossibility of a serviceable balloon or the first to study the bird wing to learn the secret of flight and of sustained elevation in the air, was perhaps the first to give serious study to the architecture of the wing of the soaring bird. He discovered the secret lay in the arched or vaulted wing, and he made a machine by which he did succeed in flying. These were only short flights, Langley's aerodrome being the first flying machine which, without the agency of a gas bag, ever succeeded in remaining in the air for a minute and a half.

Herr Lilienthal also devised a motor which was operated by means of a vapor of liquid carbonic gas. It had a force of two horse power, although it weighed less than twenty-five pounds. It was found too strong for the "wings," which were broken in one experiment, and in another broke while the inventor was high in the air, and he was dropped to the ground and killed.

Modern ballooning, by universal consent, dates from 1783, when the Montgolfiers, two brothers, made their first ascent in France. They used hydrogen gas, which Cavendish in 1766 had discovered was only about one-seventh the weight of air. The same year the first ascent in America was witnessed in this city. Rittenhouse and Hopkins, both of them members of the Philosophical Society, constructed a machine having forty-seven small hydrogen balloons attached to a car. Having first experimented with dogs and cats, they finally succeeded in engaging a man to go up in this queer contrivance. The aerostat rose successfully, but as it sailed near the Schuylkill River the occupant became frightened, and, puncturing the balloons, caused the whole contrivance to make a quick descent, the traveler escaping with a broken wrist.

Nearly all of the innumerable attempts to construct an airship made before the last ten years were based upon the principle of a dirigible balloon. The machinery was lifted and held suspended in the air by an immense bag of gas. Many of the experimenters came to tragic ends, and until comparatively recent date all inventors of airships have been at least discredited when not actually accused of charlatanry. But during the last decade there has come a marked change in the sentiment toward the airship idea. Now, it is not only the ingenious, but not too well informed, mechanic who essays to startle the world with a machine that will actually navigate the air; but scientists of reputation have become interested, and some, like Prof. Langley, are experimenting for governments.

It is the general opinion of the scientists who stand highest in the world's estimation that the problem of aerial navigation is impossible of solution through the balloon idea. The airship in which our descendants may travel, instead of being, like the balloon, lighter than the air it displaces, will rather resemble the bird, and be many times heavier.

"A balloon in the very nature of things," wrote Sir Hiram Maxim, who is an American by birth, and may be best known as the inventor of the machine gun called the Maxim gun, "has to be very light and fragile, otherwise it would not rise in the air. Its mean density is, therefore, less than the air it displaces; in other words, a mere bubble.

BALLOONS TOO WEAK.

"If it were possible to make motors which would develop 100 horse power to every pound weight, it would still be quite impossible to navigate a balloon, no matter how well made, against even a moderate breeze. It is not possible to make a balloon strong enough to be driven through the air at any considerable speed and at the same time light enough to rise in the air; therefore, balloons must always be at the mercy of a wind no greater than that which prevails at least 300 days in the year.

"Those who seek to navigate the air by machines lighter than the air have, I think, achieved the limit of accomplishment. They cannot hope for any new developments which will enable them to do much better than they have already done. The possibilities before them are extremely small. On the other hand, those who seek to navigate the air with machines heavier than air have not even made a start as yet, and the possibilities before them are very great, indeed.

"In all nature we do not find a single balloon. All nature's flying machines are heavier than the air, and depend altogether upon the development of dynamic energy. In nature's machines the amount of energy developed for a given weight is very great, indeed; but no greater than the artificial motors which we are able to produce at the present time. Petroleum motors have already been developed that are sufficiently light to propel machines which fly after the manner of a bird and we shall fly whenever we ascertain how this power may be advantageously employed. It is now only a question of time and money."

Lord Rayleigh told the members of the Royal Institution at a meeting three years ago that artificial flight was a question of the speed of the horizontal motion. A bird, he said, did not use a revolving mechanism like a screw to propel itself, but he had no doubt that a revolving mechanism was the most suitable for artificial flying machines.

Scientists now look for the solution of the difficult problem to an aeroplane, to be propelled by means of a light, powerful motor, using naphtha or some similar explosive for its propulsion. It was along these lines Sir Hiram Maxim experimented, and was rewarded with some success, and this is the general idea of Prof. Langley's aerodrome.

It was so long ago as 1842 that Henson devised the first aeroplane. The aeroplane is, in brief, a thin fixed surface, slightly inclined to the line of motion and deriving its support from the upward action of the air pressure due to speed. Motion is derived from some separate propelling arrangement. Henson, who is now almost forgotten, was among the first to appreciate the properties of the aeroplane and the first to demonstrate, with a twenty-foot model, the practicability of making a steam engine fly. His machine had a total sustaining surface of eighty square feet, and weighed about twenty-five pounds. The partial success of this model immediately resulted in the inauguration of a project to cross the Atlantic. This grand idea fell through and the aeroplane sank into oblivion until about fifteen years ago, when Prof. Langley, who had devoted many years to the subject, began to seriously consider the construction of his aerodrome. About the same time Sir Hiram Maxim, who had not then been knighted, embarked upon a similar undertaking.

WHAT MAXIM HAS DONE.

The world first heard of Maxim's airship, for Prof. Langley had conducted his operations very quietly. So did Mr. Maxim, for that matter, for even so recently as fifteen years ago the mental caliber of a man who seriously intended to construct such a machine was not generally considered very large.

Maxim conducted his experiments at his large grounds at Baldwyn's Park, near Bexley, England. His airship weighed about three and a half tons. It was worked out on the principle of the kite. Every part of his machine was constructed as lightly as possible consistent with the requisite strength. It comprised an aeroplane, constructed with steel tubes covered with fabric, pivoted to the main frame in such a manner that it might be adjusted to any required angle. Two propellers, constructed of spokes covered with silk, were mounted on the frame below the aeroplane, and by driving these propellers at varying speeds the machine might be steered to the right or left.

The propellers were driven by separate engines supplied with steam from a boiler composed of comparatively large tubes connected by tubes of very small diameter, thus giving a considerable heating surface. The heating of the boiler was effected by the combustion of vaporized hydrocarbon. By means of a condenser the necessity of carrying a large quantity of water was obviated. The machine was started on rails, one pair of these being below the wheels, another pair a short distance above them. By running the machine along and observing the angle of contact with either set of rails, the required inclination of the aeroplane was thus ascertained before the apparatus rose in the air.

With some changes in design Maxim built another airship, and on July 31, 1894, sent his machine into the air. It is claimed that this was the first time a flying machine actually left the ground, fully equipped with engines, boiler, fuel, water, and a crew of three persons. It did not remain long in the air, however,

it actually tore itself free from the guides placed to limit its flight, and only fell to earth when its sails became entangled. This machine weighed nearly 8,000 pounds. The actual force developed in the screws was 363 horse power, with a screw thrust of rather more than 2,000 pounds. The width of the aeroplane was over 200 feet. Upon setting the engines in motion it was found that when they showed a speed of thirty-six miles an hour the whole machine was lifted from the rails on which it started.

Lord Kelvin declared that Maxim had solved part of the problem of navigating the air, it being proved that a well-made screw propeller obtains a sufficient grip on the air to propel a machine at almost any speed, and that the greater the speed the higher the efficiency of the screw. Maxim was satisfied to some extent with his partial success; but experiments of this kind are very costly, and the inventor has rested upon the laurels he then won.

Prof. Langley's experiments, at a secluded bend in the Potomac River, have been conducted for the past ten years in the interest of the War Department, Congress having appropriated money for the object. These ten years do not represent the actual time the secretary of the Smithsonian has given to the subject, and he was at work down at the little station of Quantico for three years before the news got abroad that the United States was going into the airship business. Suddenly, in 1896, rumors reached the world that Prof. Langley had perfected a model airship, and that it had been successfully tried. On August 8 another model aerodrome was given a test, and although, after it had exhausted its power, it fell into the river, the scientists in charge stated that the experiment had been successful.

THE AERODROME.

Before glancing at a history of Prof. Langley's experiments, it is well to know that the machine has been named an aerodrome by Prof. Langley because it is literally what that word would imply, an "air runner." The full sized aerodrome which is soon to rise above the bosom of the Potomac will be about twenty-five times the size of the little models with which the experiments have been made. It has been built to lift an operator with it, and the trial is looked forward to with more than ordinary interest.

At first Prof. Langley studied carefully the actions of the soaring bird, and was quickly convinced that a successful flying machine was to be constructed after such study rather than attempting a dirigible balloon, for reasons already stated. His first experiments were made upon a "whirling table" of great size, driven by a steam engine, its revolving arm sweeping through a circumference of 200 feet at all speeds up to seventy miles an hour. Apparatus, usually a weight to be tested, was placed at the end of this arm and dragged through the air until its resistance supported them as a kite is supported by the wind.

One of the first things observed was that it took a certain strain to sustain a properly disposed weight while it was stationary in the air, then not only to suspend it, but to advance it rapidly at the same time took less strain than in the first case. For three years these experiments were continued, with the general conclusion that by simply moving any given weight of this form fast enough in a horizontal path it was possible to sustain it with less than one-twentieth of the power Newton's rule called for.

In particular, it was proved that if we could insure horizontal flight without friction, about 200 pounds weight could be moved through the air at the speed of an express train and sustained upon it with the expenditure of one horse power. This was saying that, so far as power alone was concerned, mechanical flight was theoretically possible with engines that could then be built, "since," adds Prof. Langley, "I was satisfied that boilers and engines could be constructed to weigh less than twenty pounds to the horse power, and that one horse power would, in theory at least, support nearly ten times that if the flight were horizontal."

Subsequently some time was spent studying the flight of Pinaud's flying toy for the purpose of learning how to balance the future aerodrome. Then came the difficulty of getting engines and boilers of sufficient lightness and strength, the greatest difficulty being experienced with the boilers. Finally, from the roof of a houseboat, anchored off the shore at Quantico on May 6, 1896, one of the models was started off, and made two successful flights.

The weight of this model was about twenty-five pounds, and it measured twelve feet from tip to tip of its "wings." It was propelled by steam, and shot through the air over a measured distance of 900 feet at an altitude of about 100 feet and a velocity between twenty and twenty-five miles an hour. It reached the water one minute and thirty-one seconds after starting.

The theory of Langley's aerodrome is that the weighty machine owes its support to the rapidity with which it runs over the air, like a skater on thin ice. Prof. Langley pronounced a new law in the course of his experiments, already known by his name, that, under certain conditions, the power required would in theory diminish indefinitely as the speed increased, and that it would actually diminish in practice up to a certain limit.

In starting the aerodrome the launching is not due to initial force generated by the machine's engines, but is thrust forward by a catapult. This force is strong enough to send the model about 200 yards, when its motor takes up the work and propels it until the steam is exhausted, when it descends.

Prof. Langley, although hopeful for the success of his aerodrome, knows how many accidents may happen to a flying machine trial, and does not feel assured that he has yet thoroughly solved the problem of aerial flight. Yet, when the large machine from which so much is expected, goes into the air, even if it fails in some of the requirements, it will not argue the professor has labored in vain. It is generally conceded by scientists that Prof. Langley has carried the movement very far forward along what is considered the right lines, and there are even some who expect that the big aerodrome will not only equal expectations, but surpass them.—Public Ledger.

AMERICANIZING SCOTLAND'S INDUSTRIES.

In an article under the caption of "Americanizing Edinburgh's Industries," the Edinburgh Dispatch of July 18, 1903, says that in many British engineering shops and other establishments American systems and methods of employment and pay have been adopted during the past two or three years. They are described in detail, as follows:

"One of the latest of these is a premium or bonus arrangement, which has been already introduced into Edinburgh and is at present in use in one of the departments of our greatest engineering establishments. This premium system might be termed an alternative to the well-known system of piecework. It has all the advantages of payment by time and none of the disadvantages of piecework, including that known as 'cutting of prices;' while it also insures that the employer will get the maximum amount of service for his plant. By it a workman receives a premium for completing any given piece of work in less than the usual time recognized for doing that work. The premium varies according to the time occupied less than the maximum; and the period allowed for the work depends on its nature, and is regulated by the practice of the trade. To take the engineering trade as an illustration, say a man is paid at the rate of 6s. ($1.46) per day and is put onto some part of a machine for the making of which six days is the recognized time. If he completes the job in five days he is paid a bonus of half a day's wages, or 3s. (73 cents). Thus, by this arrangement, he can make 33s. ($8.03) in five days and has the opportunity of making another 6s. ($1.46) by beginning a new job on the sixth day. On the other hand, if he does not finish the article in the six days he loses nothing, as he is paid so much per day whether he is working on a job or not. The advantage to the master is that he saves half a day's wage on that particular piece of work; he gets the best return from his plant and the best work of his employe, and his output is consequently increased. Another variety of this bonus system is one which is in use in many of the great factories of America. By this method a piece of work is given out to a man, and a committee, consisting of the best and most intelligent workmen in the establishment, decide not only what is the minimum space of time in which the work can be done, but also how it shall be done, the time to be spent over each operation, and even the tools to be used. This committee says to the workman: 'Here is a piece of work; if you finish it in the time we have fixed, which has been arrived at by careful examination and minute calculation, we shall pay you a bonus of half the value of the time saved. You must do it according to our calculations and directions. If you have any ideas of your own, you may suggest them, but you must not put them into practice to the abandonment of ours.' If the workman does not finish the work in the stipulated time, he not only loses his bonus, but if the committee, after consideration, thinks that he has unduly exceeded it, he is warned, and if the 'offense' be repeated the workman is summarily dealt with. Needless to say, this latter system is not regarded with much favor in this country, the former method of leaving the matter in the hands of the workman being considered the best means of encouraging him to put his skill and intelligence into the work.

THE ONE-BREAK DAY.

"The 'one-break' system is another American idea which has gained a footing in this country and is rapidly growing in favor. By this arrangement the breakfast hour is done away with, and the men start work at 7 or 8 o'clock in the morning, having had a good meal, there being only one break during the rest of the day—for dinner. It is contended that this is a much better method for both men and masters. The men do not start hungry, and being therefore fresher and better rested they are able to pay more attention, and consequently turn out more and better work. Then, again, the waste, inconvenience, and delay caused by stopping, resting at breakfast time, the annoyance of men coming in late, and the other evils of the two-break system are done away with; the output is increased, and the men are healthier and more physically fit to undertake the duties of the day. The one-break system was first introduced into Great Britain by a Leeds firm in April, 1901, and was quickly imitated by another firm in the same town. The workmen at first raised an objection, on the ground that the day was too long to work with only one break, and asked either for a reduction of hours or a withdrawal of the system. The matter was subsequently discussed at a central conference of the Engineering Employers' Federation, where it was stated that 83 firms throughout the country, of which 26 were federated firms, had adopted the system, and were on an average working a 51-hour week. The experience of these firms, it was stated, was that the workmen, after they became accustomed to them, preferred the altered hours. In 13 firms the hours were divided as follows: Monday, 8 A. M. to 6. P. M., with the dinner hour from 12 to 1 o'clock; Tuesday, Wednesday, Thursday, and Friday, 7 A. M. to 6 P. M., with the dinner hour at the same time; Saturday, 7 A. M. till noon—a total of fifty-four hours. Of course, these new methods of premiums and the one-break system are applicable to any profession, and, indeed, the latter is in use in many other professions in Edinburgh.

A PRACTICAL EXAMPLE.

"As a matter of fact, not so very long ago an innovation of a similar nature was made in a brewery bottling department where a very large number of boys are employed. These boys used to be brought in very early in the morning, and were started to work without breakfast, having a breakfast between 9 and 10. The result was that, coming in without food, the greater part of the early hours were wasted. The company came to the conclusion that, having boys to deal with, they ought to be taken in a special manner. Instead of rearranging the hours, the company decided on a somewhat novel plan. They made an arrangement whereby hot coffee and rolls were prepared for the boys immediately on their arrival. When the young workers came from home unfed and hungry they found a substantial meal awaiting them, which they took with great gusto, afterward setting about their work with redoubled liveliness and energy. In order to further encourage these lads to greater efforts, the management decided upon consideration that a certain number of dozen bottles per day would be considered a comprehensive day's work. The result has been that these lads vied with each other, having made it a matter of the keenest rivalry who should first finish their allotted number of bottles. Although the closing hour is 6 o'clock, in many cases some of the gangs—they are all arranged in separate gangs—have actually concluded their day's work by 4.30. The consequence is that there is a healthy competition among the different squads, and when 4.30 or some such hour arrives the first gang is finished, and others hurry up to be equal with them, the next hour or so being spent in relaxation with the concurrence of their employers. Then they get away home refreshed and unwearied with excessive labor, and are eager to turn out sharp and punctual in the morning. More than that, the company offered a premium to their boys who kept good time in the morning, and it turns out that the coffee and rolls and premium combined have had such an effect that the firm has benefited to an extent it never dreamed of when the idea originated.

ONE OF THE DIFFICULTIES.

"Interviewed the other day on the subject of premiums by a Dispatch representative, a member of a big engineering firm in Edinburgh said: 'On the whole it would be an undoubted advantage, but not of such a nature that everyone would be likely to adopt it. One of the difficulties of the system would be to define when the benefit of increased output was created by the workman, and when it was the result of improvements introduced at the expense of the employer. In large establishments improved machinery is constantly being introduced, and it often happens that a great deal of the decreased time in completing a given piece of work arises not from the workman's exertions, but from improvements at the master's cost. Far more improvements in this direction emanate from the management.' Asked what he thought of the one-break system, this gentleman replied: 'There is no doubt about it; the one-break system is a very much better arrangement.'

VIEWS FROM GLASGOW AND THE WEST.

"With the motor-car boom, these new industrial methods have gained a footing in Glasgow. Several of the large motor-car manufacturing firms, including the Mo-Car Syndicate at Paisley, have adopted the premium-paying system, by which the men are encouraged to do more than the minimum expected of them by sharing in the extra profit accruing. Other firms are more conservative in their methods; but the advantages of the American system are recognized by their managers, although they hesitate at the moment of upheaval that would be entailed in upsetting present customs. The manager of the largest cycle works in Glasgow, in conversation with a representative of the Dispatch, was ready to admit that one feature of American engineering would be distinctly advantageous—a working day with only one break for dinner, involving the abolition of the breakfast hour and the starting of the works an hour or two later than 6 o'clock, the orthodox starting hour for engineers. There is always a certain amount of leakage in stopping and restarting the men and machinery, which would thus be saved, and in the case of large works employing several hundred hands the saving would be considerable. Even Glasgow employers, however, place a great deal of faith in the policy of hastening slowly.

"In another quarter the American system of bonus paying has been receiving some attention. An attempt was made recently at Kilmarnock to introduce the progressive premium system, as it is called, into the iron works, but it met with opposition on the part of the employes. In the case of one Dundee engineering firm the proposals have taken practical shape and are undergoing consideration on the part of the workmen. Some attention has also been given to the subject in Glasgow. A representative of the iron molders, in the course of a conversation on the subject, stated that the men were not at all averse to employers adopting this system where there was a large amount of capital sunk in plant, it being to the employers' advantage, of course, to get the best return possible from their expensive machinery, where the oncost charges are heavy and wages do not practically form the sole item in the cost of production.

WHAT THE IRON MOLDERS THINK.

"In the case of iron molders, however, it is different. Their point of view is expressed in a recent report of their association, in which the premium system is discussed. It states that the premium system, 'as we understand it, means that any workman who may require, say, nine hours to produce or make a piece of work is to be asked to do it if he can in seven hours, and he will receive an hour's pay as bonus—i. e., to be paid for eight hours; or, if a workman takes forty hours to complete a job, if he can do it in thirty-five hours or less he gets the one-half as a bonus. This mode of working would apply to time workers. The foreman and manager will consult over any pattern and consider how many hours this should be cast in, and also the time noted when it is taken out of mold, and sand restored to a working condition ready for another job. The workman gets a card from the foreman when he gets his pattern. At the top of the card is the number of hours allotted to begin and fully complete that job. Should he take four or five hours longer, he will be paid certainly, but an inquiry will be held and a satisfactory reason for such delay is expected. This system of work may do for some trades, but in molding unforeseen obstacles, which can not always be provided for, continually face the workman, and in our opinion should this plan become general the middling and poor workman will fare badly. It is said by the advocates for such a system that no honest employer will reduce a time once given for a job, should any workman make a good premium, but to our mind this premium system would be worse and morally debasing to any other system we know of.'"

COLD STORAGE IN HORTICULTURE.

THE rôle of cold storage is becoming more and more important in horticulture, not only in the preservation of food products, such as fruits and vegetables, but also in the retarding of the vegetation of the bulbs of lilies, hyacinths, and tulips, the rhizomes of lilies-of-the-valley, and clumps of lilacs, snowballs, roses, deutzias, and azaleas, in order to obtain flowers therefrom long after their regular period of blossoming has passed.

It is principally in the United States, England, and Germany that this industry has become most extensively developed, and the French producers of flowers are at present dependent upon the two last-named countries. A lecture replete with interest was recently delivered upon this subject at Berlin by Herr Meekel, and was received with such favor that we shall endeavor to present the essential points of it.

It was not very long ago that the possibility of preserving fruits for quite a long time in such a state that they could be kept and transported without losing their edible and commercial value was unknown. At present, Florida and California are currently shipping strawberries in cold-storage cars to New York, where they are to be found exposed for sale for eight months in the year, while formerly they were to be seen but during three months. Canada and Australia are shipping peaches, grapes, apples, etc., to London and Paris with the same success. One of our friends, the superintendent of a large establishment at Yokohama, writes us that the shipment of lily bulbs thence to Europe in cold-storage chambers on ships was begun last year.

One of the essential conditions for the proper preservation of perishable products, independently of a stable temperature, is that the chambers shall be dry, the air be pure, and that in taking the fruit out of storage it shall not be suddenly exposed to variations of temperature. The preservation of apples and grapes can thus be extended to eight months, that of pears and oranges to four months, and that of strawberries, gooseberries, and raspberries to from three to six weeks.

It is also a simple matter to arrest the vegetation of a number of plants and render them flowering independent of the season. But it is necessary that such plants, the activity of which is momentarily arrested, shall be furnished with the temperature and humidity of air that the vital conditions of each of them require.

Thus for the rhizomes of the lily-of-the-valley, clumps of lilac, deutzia, spiræa, azalea, etc., it is necessary to maintain a temperature of two or three degrees C. below zero in the chamber in which they are stored. Lilies and roses, on the contrary, require one or two degrees above zero. Fig. 1 gives an interior view of a cold-storage establishment with the corresponding mechanical installations. This establishment is divided into several chambers which open upon one and the same passageway. Independent refrigerating pipes, as well as conduits for the air, exist in all the chambers, and permit of varying the temperature and hygrometric state of each of them. In fact, a cold saline liquid is passed through the pipes, or else a cold and dry air apparatus is brought into requisition, according to the degree of dryness to be obtained. In order to prevent a loss of cold to as great a degree as possible, the partition walls, floors, ceilings, and double floors are lined with a material which is a poor conductor of heat. In another cold-storage establishment which has an area of about 1,000 square feet, the cold is produced by a small-sized upright frigorific machine (Fig. 2), which is covered in order to protect the belts, and is actuated by a gas engine. The apparatus for cooling and condensing the air are combined and placed, along with the pump, in an annex to the engine room. For an installation of this size, the cost of running is sensibly the same whether a gas or a steam motor be employed, while electric power would be more costly. It is evident that for a larger establishment, a steam engine is preferable, for economic reasons.

Such an installation is so arranged as to receive plants and bulbs that have already been retarded in a horticultural establishment of some size. The cost of constructing it may be estimated at $2,800 and the annual expense of running it at $600. An establishment of this kind would permit, in setting apart the large chamber for lilies-of-the-valley, and the three smaller ones for rose bushes, various shrubs, and lily bulbs, of storing at once 1,500,000 rhizomes of lilies-of-the-valley, 28,000 lily bulbs, and several hundred shrubs. Such plants and bulbs are placed upon shelves arranged for the purpose and properly spaced. The lily bulbs must be absolutely perfect when placed in these chambers, since a single contaminated one might spoil all those of a case. These bulbs are arranged in boxes on cocoanut fiber and the boxes are afterward so placed upon the shelves that the cold can penetrate each case.

In the city of Hamburg there are at present immense cold-storage establishments in which a constant temperature of from three to five degrees of cold is kept up all the summer, and in which thousands of cases each containing from 2,500 to 3,000 lily-of-the-valley rhizomes remain entirely congealed until the time arrives for setting them out. These plants flower from May to December, the epoch at which the rhizomes of the same year are forced. The annual exports of these rhizomes from the Hamburg cold-storage establishments amount to $200,000. We do not think, however, that there are any cold-storage establishments for the preservation of living plants that approach in magnitude that of Thomas Rocheford, who annually sells in England and exports to France several million dollars' worth of lily-of-the-valley rhizomes, Bermuda lilies, lilies with rose-colored flowers, etc.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

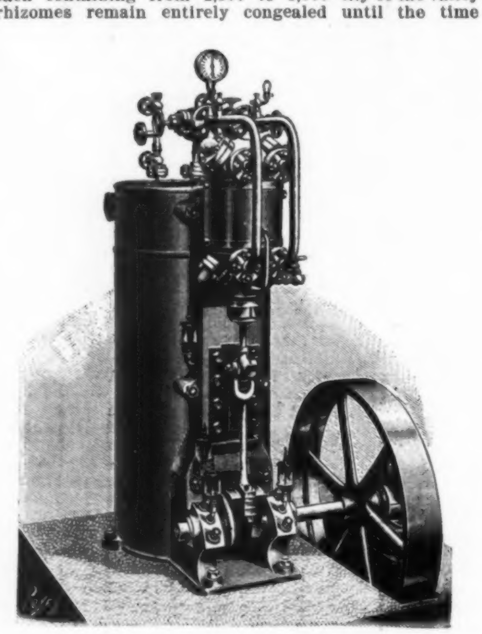


FIG. 2.—FRIGORIFIC MACHINE.

FIG. 1.—COLD-STORAGE ESTABLISHMENT FOR THE PRESERVATION OF FOOD PRODUCTS AND PLANTS.

THE EUCALYPTS.

YOUR reviewer of two recent works on eucalypts (April 2, p. 524) seems to require correction on certain points. *Eucalyptus globulus* cannot be considered as the first in economic importance among the eucalypts. In almost every shade of extra-tropical climate there is to be found a eucalypt which will grow as well, or better, than *E. globulus*, and yield a far superior timber. It is generally held now that eucalypt planting has suffered by the indiscriminate praise showered on *E. globulus* by the early eucalypt enthusiasts.

Your reviewer says, further, that eucalypt plantations now exist in Italy, France, Algeria, California, and other countries. He does not appear to be aware that there is probably more eucalypt planting in South Africa than in any other country, and that at the present rate of progress there will, in a few years, be more eucalypt plantations in South Africa than in all the other countries combined. There is no group of trees in the warm temperate regions of the world that can produce hardwoods of good quality so rapidly and so cheaply as eucalypts, and their cultivation bids fair to become the central factor in the forestry of these regions. At this moment trainloads of eucalypt timber are pouring into South Africa, eucalypt sleepers displacing metal and creosoted-pine sleepers. South Africa will soon be paying out something like a quarter of a million pounds yearly for eucalypt timber imported for railway sleepers and mining timber (little or none of this, by the way, *E. globulus*), so that any delay in the prosecution of eucalypt planting in South Africa would be a most expensive proceeding. It is noteworthy that, so long as the eucalypt is properly fitted to its climate, it seems to grow better in South Africa than in Australia, the explanation being probably that all the eucalypts in South Africa have been raised from seed, and are thus growing in South Africa free from their Australian pests, both fungus and insect. With the view of preserving this happy immunity from disease, the importation of eucalypt plants into Cape Colony is placed under stringent restrictions.

The meritorious work of Messrs. R. T. Baker and H. G. Smith, if carried to a conclusion, should be the classic for many years on eucalyptus oil. Your reviewer is mistaken in saying that practically all the eucalypt species indigenous to Australia are included in their work. Practically, all the eucalypts are indigenous to Australia, but they are not included in Messrs. Baker and Smith's work, which embraces 112 out of 120 described species of New South Wales and a few others from the neighboring colonies of Eastern Australia, but none of the well-known timber eucalypts of Western Australia, jarrah, kari, touart, red gum, York gum, etc.

It is a little disappointing that the authors were unable to obtain leaves of such a prominent eucalypt as *Eucalyptus regnans*, the tree which shares with *E. diversicolor* the honor of being the tallest tree in the world. It is common enough in the government plantations near Cape Town, as is also *E. alpina*, which figures also in the list of unprocurables. It is particularly unfortunate that they have not tested *Eucalyptus calophylla*, the type of the parallel veined eucalypts. This is a West Australian species.

Messrs. Baker and Smith state that forty tons of eucalypt leaves were used and 500 distillations made. Their work is a model of painstaking investigation, and to the chemist and those interested in the oil industry will no doubt prove extremely useful.

But the authors have not confined themselves to the chemistry of eucalyptus oil. They propose a number of new eucalypt species and a new classification of eucalypts. How far the numerous new species will stand the test of critical investigation in the field remains to be seen. Many of their new species have already been contested.

Messrs. Baker and Smith have discovered that there is a relation between the venation of eucalypt leaves and the chemical constitution of the oils of the leaves. Parallel veins and pinene go together. Many of the parallel-veined leaves smell of turpentine like a pine leaf. Then come the peppermint eucalpts, containing piperitone, with a more complex venation, and then a still more complex venation yielding oils rich in eucalyptol or cineol, which is the valuable constituent in the best eucalypt oils. This is a very interesting and important correlation, especially if further investigation shows that it holds good through the whole eucalypt genus. As chemists, one can pardon the authors their enthusiasm over it. But whether it is sufficient to found a new classification of eucalypts on may be doubted. We have numerous eucalypt classifications in the field. There is that which is generally accepted in default of a better, the anthereal system of Bentham, somewhat modified and simplified, but not improved in Mueller's subsequent works. There is a (perhaps more practical) bark system, and there are various obselete systems founded on the shape of the cones and the flower buds. As Messrs. Baker and Smith most justly remark, a natural classification founded on a combination of all these, including the quality and structure of the timber, has yet to be made. It is not likely that their oil-and-vein classification will be sufficient in itself. It seems unlikely that any one, except a scientifically trained forester, who has spent a large portion of his life among the eucalypts in their natural forests, will be able to construct a sound natural grouping of the species of this difficult genus. The work will require a Mathieu, a Brandis, or a Gamble, that is to say, a practical forester with special scientific qualifications. It is not to be done with botanical specimens as Bentham and Mueller attempted it, nor with practical knowledge alone as Wools attempted it, nor in a chemical laboratory, where Messrs. Baker and Smith have done most of their work! It is true that Mr. Maiden is now bringing out a "Critical Revision of the Genus Eucalyptus," and from this, with his great reputation as a practical botanist, much is expected. The first number, on the very important species *Eucalyptus pilularis* and its allies, has already appeared, also Part II. on *E. obliqua* and the gum-top stringy barks.

In view of the differences in the quality of the oil yielded by various eucalypts, the authors advocate plantations in certain circumstances of good oil-yielding species. The lopping they suggest a forester would replace by coppicing. It is believed that all eucalypts coppice well. Most of them will stand a considerable amount of lopping, but it eventually kills them. It is only in a few instances that species of eucalypts are found predominating over an area of country to any great extent, so that a particular species being worked for its oil may soon be cut out in close proximity to a permanent plant. But some eucalypts are very tenacious of life, and "suckers" soon spring from the stumps of the trees cut down; it is thus only a matter of a few years when fresh material is again obtainable. This may be seen from the photograph of *E. Smithii*, where most of the dense growth is from "suckers" of this nature. We have been able to show, in several instances, that the oil obtainable from this young growth is of the same character as that obtained from the mature leaves, so that no great difference in the quality of the oil need be expected. But we think it to be a pity that the trees should, in many instances, be felled for their leaves alone. By judicious lopping a fresh supply of leaves could more quickly be obtained, so that a permanent supply might be assured. There are a few species of eucalyptus, however, which form the prevailing vegetation in certain localities, and are found growing gregariously in their native habitat; this is particularly the case with some of the "mallees." In New South Wales there are several species of this nature, as, for instance, the "blue mallee," *E. polybractea*; the "red," or "water mallee," *E. oleosa*; the "gray mallee," *E. Morrisii*; and the

"Argyle apple," *E. cinerea*; all these species give good eucalyptol oils, and all are more or less gregarious in their habits, so that natural plantations of these species are practically ready to hand; but besides these naturally covered areas the question of the cultivation of certain eucalyptus species is of importance in this connection.

It may possibly be accepted as conclusive that some eucalyptus species are not inexhaustible under certain conditions, and it is worthy of consideration whether plantations of young trees of *Eucalyptus Macarthuri*, for instance, might not be profitably cultivated for the preparation of its valuable geranyl-acetate oil. So with the eucalyptol oils, it is probable that the cultivation of some species, *E. Smithii*, for instance, could be profitably undertaken, and from which young growth an oil could be distilled that would compete satisfactorily, both in price and eucalyptol content, with any European oil of this class.

A minor fault running all through their book is their use of the word "sucker." By "sucker" is properly understood shoots from the roots, such as one sees in poplars, elms, and willows. Eucalypts do not sucker (except rarely and accidentally), and the authors use the word in the sense of "coppice shoot." No doubt "sucker" is an Australian colloquialism, but naturally the use of slang expressions is to be avoided in a scientific work. To be accurate the authors should use the term early or first foliage, or its equivalent, since this important diagnostic feature is seen in the first foliage of eucalypt seedlings equally with coppice-shoots.

As yet no one of the Australian colonies has taken the first step in scientific forestry. Though Mr. Maiden in his various writings has let in a flood of light on the subject, and the student of eucalypts stands deeply in his debt, there is not a line by a scientifically trained forester descriptive of the forests of Australia. There is no want of liberality on the part of Australia in endowing the researches of scientific men living in cities, but there is a woeful neglect of forestry in the field. Scientific forestry as understood on the continent of Europe is unknown in Australia, and unless the commonwealth can bring its attention to bear on the terrible waste of its natural forest resources now going forward, its future history will be a black one, comparable only in modern times to that of the Spaniards in Mexico.

In the older settlements of East Australia the forests, pillaged of their best species, or burnt and ruined, have greatly declined in value. Gone are the valuable reserves of iron-bark, tallow-wood, and forest mahogany among the eucalypts, and the splendid cedars (*Cedrela toona*) which should have been the country's pride. South Africa is getting most of its timber from the comparatively newly settled West Australia. The Australian has yet to learn to take the honey without destroying the bees.

When your reviewer takes us to America, we get among a people awakening to the fact that there is such a thing as scientific forestry. As he remarks, the American volume on eucalypts is excellently gotten up. It is a pleasure to turn over the pages with their life-like pictures of eucalypts. It is not likely, however, that there will ever be any great production of eucalypt timber in North America. It is only South California that quite repeats any Australian climate, namely, southwest Australia. It is doubtful if eucalypts will ever do much in the Eastern States. The Gulf States, which are alone suited to eucalypts, have their cold snaps and freezes, together with an all-the-year-round rainfall which we do not find in Australia, while there is an abundance of good hardwood already in the country, and the four pitch-pines, rivaling hardwoods in strength and durability. Eucalypt culture in America is still in its infancy; they have not yet discriminated the valuable from the many worthless species, nor fitted, as far as may be, the species to its climate.—D. E. and E. Hutchins in Nature.

RAIN AS A CLEANSING AGENT.

SOME interesting facts regarding the purifying effect on the air of heavy rain are given in the Lancet. The writer says: We have often pointed out that the passage of raindrops through the air not only purifies the air, but imparts a freshening effect to it, due possibly to an oxidizing action, and perhaps to the formation of peroxide of hydrogen. Every one is familiar with the "clean" smell of the air after a rainstorm. According to this view the air of the county of London must have received a very thorough scouring during the remarkably continuous rainfall which began on Saturday, June 13. There was very little movement in the air, and an opportunity was thus afforded of collecting the water for analysis, the results of which would represent some, at any rate, of the impurities washed out of the air immediately over this area. The following were the results obtained with raindrops caught in the neighborhood of the Strand on Monday, June 15:

	Grains per gallon.
Total solid matters	9.100
Common salt	0.800
Ammonium sulphate	0.652
Organic ammonia	0.011
Soot and suspended matters	5.000
Nitrates	None.
Nitrites	Very distinct.

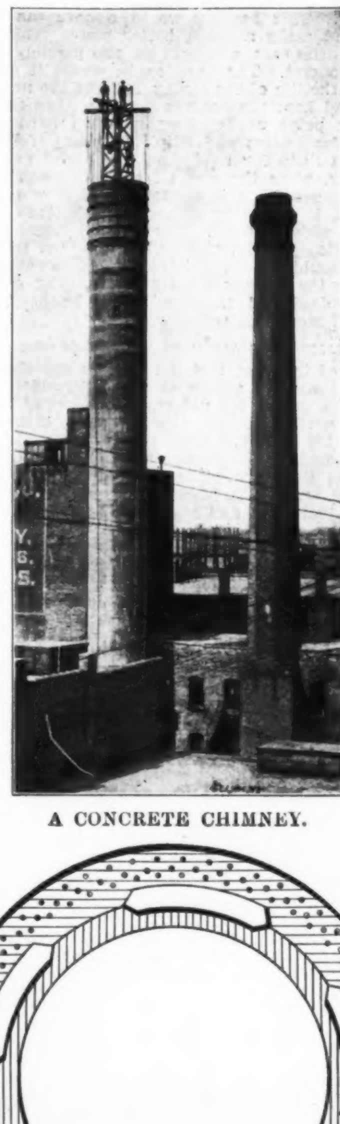
The amount of ammonia in the form of sulphate is remarkable, and, of course, its chief origin is the combustion of coal. The nitrites with traces of ammonia are due to electrical discharge in the atmosphere. These results, when worked out with the total rainfall, give some remarkable figures. Taking the rainfall as 3.8 inches in five days (though a higher figure than that has been returned by some observers) we arrive at the calculation, based on each inch representing 22,622 gallons of water falling upon one acre and the London county acreage as 74,839, that no less than 6,437,229,860 gallons of water were poured over this area. And, according to the above results of the analysis of the rain-water, this enormous volume represents the washing out of no less than 3,738 tons of solid impurities, of which 330 tons consisted of common salt, 267 tons of sulphate of ammonia, and 2,000 tons of soot and suspended matters. Regarding the combustion of one ton of coal to produce twenty pounds of ammonium sulphate (a very fair average), the quantity of coal represented by the ammonium sulphate washed out by the storm would be 29,904 tons. It need hardly be added that the purification is not only, as is here shown, mechanical, physical, and chemical, but bacteriological also.

A CONCRETE CHIMNEY.*

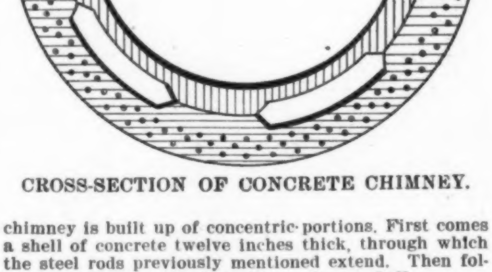
By OSCAR GREENWALD.

MILWAUKEE, Wis., boasts of a concrete chimney, which, in its way, is something of a novelty. As a foundation, a hundred 60-foot piles were used. Upon this a concrete base 14 by 20 feet was placed. The chimney itself is 170 feet high, has an internal diameter of 90 inches and an external diameter of 12 feet, 4 inches. Through the entire length of the concrete, heavy iron rods extend, spaced one foot apart. They serve the purpose of holding the material of the chimney together. In addition to these vertical rods, circular rods or bands are also employed, spaced twelve inches apart.

As shown in the accompanying cross-section, the



A CONCRETE CHIMNEY.



CROSS-SECTION OF CONCRETE CHIMNEY.

chimney is built up of concentric portions. First comes a shell of concrete twelve inches thick, through which the steel rods previously mentioned extend. Then follows an air space, and finally an inner shell.

In the construction of the chimney, a wooden mold twelve feet in length was first placed in position. After having been filled in for a distance of six feet and the concrete allowed to set, the mold was lifted for another five feet and again filled in. Our illustration shows the chimney thus constructed to a height of 150 feet. When the molds have reached the height of 175 feet, a molded cap will be placed on the top of the chimney. It is hoped that this new chimney will do away with much of the smoke of the old chimney, which it is intended to supplant.

Concession to Mine Phosphate in Barbuda.—The Board of Trade Journal, London, says that the government of Antigua will receive, up to October 1, 1903, at the office of the colonial secretary, Antigua, tenders for a concession to mine phosphate of lime or alumina in the island of Barbuda. All information may be obtained from the Crown agents for the colonies, Downing Street, London, S. W.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

SPRINGS.*

By WILLIAM METCALF.

IN compliance with a request for a paper on the subject of springs, it may be well to begin with a short history of the conditions and changes that have occurred in the past thirty years in car and locomotive springs.

Thirty years ago, when the writer first became interested in springs, Bessemer and open hearth steel were undeveloped infants and their uses were mostly experimental for everything except rails and plates. Bolster springs were made mostly of gum, gum and coils of steel around them, and gum in boxes in great variety; also of coiled springs of astonishing variety. They were helices and volutes, round, square, flat, beveled, oval, egg shaped, and nondescript sections of bars, used for both bolster and draw bar springs, of steel made of either the old style German steel or of crucible steel. There were double, single and half volutes, and helices in groups of single coils, and others of different diameters one within the other. For elliptic springs we had flat, concave, ribbed, and corrugated bars.

These springs were covered by patents as numerous as the varieties, and, of course, each kind of spring was the best in the market. Specifications for springs were limited to space to be occupied and load to be carried. It was go as you please for the manufacturer, scrambling and fun for the traveling men, and all around confusion worse confounded.

THE ADVENT OF CHEAP STEELS.

The gradual introduction of open hearth and Bessemer steels, sure winners because of their cheapness, promptly drove out the gum altogether, and more slowly but inevitably drove out the crucible steel. Crucible car spring steel is still heard of occasionally from the few who have not advanced with the art. The first effect of the introduction of these cheaper steels was breakages innumerable, until careful railroad men were driven nearly wild.

Before crucible steel was entirely driven out, one maker was asked to make the lightest possible spring to go into a given space and carry a given load for the then common 30,000 pound freight car. The result was 32 pounds to a group, 128 pounds to a car. They worked admirably, the springs were adopted and many thousands were ordered from different makers. A few months later the same maker was asked to make the heaviest spring he could put into the same space for the same load, because the light springs were breaking faster than they could be replaced. The result was a nest that weighed 72 pounds, or 288 pounds to a car, a gain of 160 pounds for the manufacturer.

Shortly after he was sent for again to consult about a proper specification, to which he replied that the proper specification was to specify his springs, and he was told promptly that the great railroads of the country could not, and would not, be tied to one concern; that although they were buying springs on a five-year guarantee, the breakages were so great, even of the heavy springs, that to insist upon the guarantee would, they were sure, break up every one of the spring makers, and that would be the worst break of all. To take a back step and return to gum and crucible steel exclusively would be a confession of weakness in the mechanical department amounting to almost imbecility, and there seemed to be no relief except through a scientific study, careful experiment and proper specifications. This was the beginning of specifications for springs, and probably the leader for many others.

THE FIRST SPRING STEEL SPECIFICATION.

The first specification of which the writer has any knowledge was for the steel, and was due to our worthy president. He wisely ignored the mode of manufacture and devoted himself to getting the best material consistent with reasonable cost of manufacture, not demanding something impracticable, not expecting a dress suit at a shoddy price, and equally determined not to have shoddy when he paid for good wool. For one, the writer kicked against the close limit on carbon, and all to no purpose. The result was the now famous and almost universally accepted Pennsylvania Railroad specification for spring steel, now known everywhere as the "Standard Specification Spring Steel," and it has proved to be entirely reasonable because it can be made for a reasonable price, and when it is well made it is entirely satisfactory.

Following this, there came from the mechanical department of the same railroad the first reasonable and sensible specification for coiled springs. A circular section, the round bar, was adopted for all coils because the strain was torsional and the round section gave the maximum resistance to torsion.

Calculated from the best known formula for torsion, a complete set of springs was designed for the various uses about a car. Upon the first trial the springs proved to be about 33 per cent too strong. This led to a discussion between the spring makers and the railroad engineers as to who was at fault. Naturally each fellow insisted that he was right and the other fellow was wrong. The writer took the matter up by making some springs that were of the specified composition and the bars of the specified size as exactly as they could be rolled on a large scale, not going into a refinement of thousandths of an inch. Then he saw that they were treated properly both in the coiling and in the hardening and tempering. They were certainly about 33 per cent too strong.

This led to a consideration of the formula. It seemed at first sight that if torsion were the only resistance the closing down of a coil must lead to a compression of the tempered steel that was simply impossible. Then where did the steel go in compressing the spring? Probably the ends slipped around the base, adding so much to the coils. A spring was placed in the testing machine between two clean, smooth steel plates and the position of the ends marked. Upon compressing the spring the ends did not move. Next the pressure was released, and by means of a small square set against the sides of the spring

* Paper read before the American Society for Testing Materials, Delaware Water Gap, Pa., July, 1903.

the diameter was marked on the base plate as well as the ends; then the spring was closed again, and again the ends did not move. A trial with the square now showed that the spring had increased in diameter at its middle height ¼ inch; it was barrel shaped. The spring was 6 inches in diameter and 8 inches high; this meant that the pressure had bulged a 6-inch half circle arch ⅛ inch at the crown, or it had apparently expanded a 6-inch circle ¼ inch in its diameter.

This accounted for the increased strength above the formula requirement, and also when the writer considered the complication of strains involved in a combination of torsion and flexure produced by an end pressure, it drove from his mind any further consideration of a formula. There may be mathematicians who could figure it out, but the writer is certainly not one of them.

HARDENING AND TEMPERING.

Assuming now that the springs are formed either by coiling the helices or arching the plates of ellipticss, the next operation is the hardening and tempering. Although the differences in temperature necessary to produce the best hardening for different quantities of carbon are apparently slight, as shown by the heat color, they are very important, and are best acquired by the experienced eye possessed by a man of good judgment and not color blind. The hardening and tempering of coiled springs is a comparatively simple matter if the temperer knows the carbon with which he is dealing.

The objection to the carbon limits mentioned before was that we had been accustomed to making springs of every carbon, from 0.60 to 1.30, and the limiting of carbon to 0.90 to 1.10 threw out of use a large amount of steel. Now that specifications have been changed so that coiled springs may be of any carbon from 0.70 to the highest, that objection has been removed, and the results will be just as good if the best conditions are observed.

The lower carbons should be put into the larger bars, because the largest bars are the most difficult to harden safely, and the difficulty increases in a geometrical ratio with the increase in carbon. A good rule is to put the 0.70 to 0.90 carbon into bars of more than 1 inch diameter; bars from 1 to ¾ inch, 0.90 to 1.10 carbon; bars from ¾ to ½ inch, 1.10 to 1.20 or even 1.30 carbon, and little rods below ½ inch into any high carbon up to as much as 1.45.

This was the old practice with crucible steel, and the spring makers were always informed of the carbon they had to deal with. The result was that breakages in the shop or failures in service were very rare. Steel of 0.60 to 0.90 carbon was hardened in water; sometimes, with about 0.90 carbon, a film of oil was used on the water. From 0.90 to 1.10 carbon, about 4 or 5 inches of oil was used on the water, and for higher steel oil was used and kept cool by an external tank of cold circulating water, or by a coil of pipe inside of the tank with cold water running through.

Coiled springs require so little manipulation after coiling that they are usually at a proper heat for hardening as they leave the machine. Care should be taken, however, in heating for coiling; they should be of an even temperature throughout the bar, and neither too hot nor too cold. If they are too hot the grain will be coarse and fiery, and even if they do not happen to break in testing they will be brittle and liable to break in service. If too cold they will not harden thoroughly, and if they do not set in testing they will probably set in service.

As to the heat, it needs to be slightly higher for mild steel than for high carbon. In general it should be just a slight shade above the recalescent point, but that is a matter not readily grasped by the average worker, and a good practice is to aim for a nice, medium orange color for high steel, and a little brighter orange for the milder steels. Good sense and experience and honest attention to the work are the best guides.

Tempering must be suited to the carbons; 0.70 to 0.80 carbon will require very little drawing; 0.90 to 1.10 may require the oil on them to flash, and for higher carbons the oil may be burned off. Above 1.30 carbon a heat that barely begins to show color will generally give a good spring temper. In tempering as in hardening good sense and good judgment are the best guides.

Helical extension springs require more care and exact treatment than compression springs. Whether it be that they are liable to be pulled out so as to be strained beyond the elastic limit, or that the uncoiling is in a continued direction of some strains set up in coiling and so causing more injurious strains, the writer cannot say, but a large experience has demonstrated clearly that extension springs as compared to compression springs are much the more troublesome, so that great care must be used to produce satisfactory results.

ELLIPTIC SPRINGS.

In dealing with elliptic springs the problem is somewhat different from that of coiled springs. There are many more pieces to deal with, and each one must be shaped, hardened, and tempered separately, and then all assembled and brought to a neat fit. The heating for shaping and hardening and tempering should be done carefully, and in general the same as has been described for coiled springs.

It seems to be the fact that there is comparatively little trouble with double elliptics, because, probably, when they are closed down solid they have a bearing upon their two parts, just as a coiled compression spring has, and, therefore, they are not liable to be strained beyond the elastic limit unless they receive a blow that is powerful enough to crush and break the material.

The case of the semi-elliptic, where the spring rests on the middle with the ends turned up to receive the load, as in a locomotive, is very different and is comparable to the case of the coiled extension spring; there is no final bearing for the ends, and by a sudden jar, causing an excessive motion, they may be strained away beyond the elastic limit and broken. It is understood that these springs now give more trouble than any others, and that to get them satisfactory is a serious problem.

The standard specification for locomotive spring steel retains the original low limits for phosphorus, sulphur, silicon, and manganese, and carbon between 0.90 and 1.10. This is well, first, to insure good material as far as it is possible to get it, and, second, because all of the bars are flat, of nearly the same section, and there is no reason for allowing a wider range in carbon. Steel can be had within these limits without any increase of cost and, now that coiled springs may be of any carbon, from 0.70 to the highest, all off heats can be used for helicals without any loss to the steel maker.

It is a common practice to form the plates in a mold, take them out and adjust them to a templet; twist them a little here, pound them with a hammer there, hold another spot with cold tongs, and finally, when the pieces are shaped to the taste of the operator and are of many different colors of heat and strained here and there by hammer blows, to plunge them into the oil bath to harden them. This is certainly all wrong. It is a quick, cheap way to get out a big product, and it is sure that every plate so treated is dosed with injurious strains that may result in a mysterious and unaccountable fracture.

Plates so manipulated should be put into a proper furnace and brought to a uniform, correct heat before quenching. This heating would remove the uneven strains and make a much better plate. This would require a little care, a little time, and possibly a small increase in cost. The question is, would it pay if it increased the life of the spring, reduced the number of breaks, and kept the engines longer on the road?

Another point needs attention when hardening in oil, both for helices and elliptics. The oil should be watched, a little fresh oil should be added every day, and finally, when the whole mass has become pretty well burned, so that it appears as if it were mixed with sand, it should be thrown out, the tank cleaned and filled with fresh oil. Worn-out oil loses its power of convection largely, and will not harden the pieces as they should be. If it is attempted to correct this by having the springs a little hotter, then the grain will be raised and the result will be fiery, brittle plates and more mysterious breaks.

THE SAME LAWS APPLY TO ALL GRADES OF STEEL.

Compared to a fine tool, a razor, or any similar article, a locomotive spring is a comparatively coarse article, but nature did not make one set of laws for steel for milling cutters, taps, reamers, etc., and another set for steel for locomotive springs. The laws are all the same, the strains are the same, the sensitiveness is the same. The average spring steel contains more impurities, phosphorus, sulphur, and so on, than fine tool steel, and just for that reason it is not only not so strong in the tempered condition as the finer steel, but it is also far more sensitive to uneven strains and will break under conditions that a piece of finer steel would endure safely.

In the absence of laboratory tests and exact data on these points it may be well to illustrate them by the action of clock springs and watch springs, which are fine enough to answer the purpose of laboratory work. These springs are spirals, and when well made are really wonderful in their work. Probably every one here has a watch which runs year in and year out with great regularity, and the running is done by a little spring that drives machinery of many times its own weight, often with a variation in speed of only a few seconds a month.

A watch main spring about 0.002 or 0.003 inch thick, less than ⅛ inch wide, and several feet long, should be made of steel of 1.30 to 1.49 carbon. The first attempts to make this steel in the United States led to trouble, of course. The steel was not uniform in quality and was not properly melted, because it showed all sorts of temper in the same spring. It developed some other tempers also.

The requirement of the spring maker was that the spring must be a perfect spiral. When pulled out straight and allowed to snap back it must coil into a spiral of even space between the coils through its whole length; also it must, when tempered, be of a perfectly even beautiful blue color. Such springs were submitted to the steel makers and they certainly were admirable works of art.

The American springs were of any shape, as far as even coiling went. They touched at one spot, were too far apart at another, and so on; were any color, from a dark, dingy blue to a brown; therefore, the steel was not of uniform quality and so badly melted that the carbon was not evenly distributed. There was no room for argument, the springs told their own story.

The steel-makers knew that the steel was uniform in quality and in carbon, that it was thoroughly well melted and that the carbon was as evenly distributed as it was possible to have it in any steel. It was now their business to find the cause of the trouble. After two or three years of struggling with the problem, the cause was found in the annealing. The steel was cold rolled in long strips about 3 inches wide and 100 to 200 feet long. To get it down to 0.003 inch thick it had to be annealed, pickled, washed in lime water and baked about six to eight times, and it can be readily seen that this required great care, skill, and close attention.

The annealing was done in boxes, packed with coils of steel filled in with fine charcoal, and the cover was luted on carefully. In spite of all care, the troubles recurred; some coils made beautiful springs, others were worthless. Finally a wise and expert drawer of fine wire, Edwin Kidd, now of the Globe Wire Company, asserted positively that steel never could be made right by annealing in closed boxes; it must be annealed in an open furnace so arranged that no flame could strike the steel directly, and yet not in a muffle. Then the operator can watch each coil, turn it and watch it until it is heated just right, and then remove it from the furnace and place it in a warm, dry place to cool slowly. It was thought that his plan was impracticable, but the case was desperate and the plan was tried with most remarkable results. It was a brilliant success, and that steel soon became famous for its excellence.

What is the explanation? It is very simple when you know, but it was a hard road to travel to the knowledge. In annealing in boxes the steel could not be seen and the heat could not be known. Then the charcoal would become incandescent and run the heat too high, and the coil would be much hotter on one side than on the other. That meant that part of the coil would be of one grain and part of another grain and greatly different structure.

This difference in structure would remain in the steel until the spring was finished and ready for hardening and tempering. The heating would require but a few moments, and when heated the spring would have to be quenched immediately, because its small size admitted of no time for manipulation. Now, although the structure of steel changes rapidly in answer to any change of temperature, yet it does require a little time, and in this case that little time could not be allowed, the grain of the spring could not be evened up, and the result was an uneven spiral, varying color, and a bad spring all around, until the steel was annealed to an even grain and structure.

Consider this now as a long continued, worrying, and costly laboratory experiment, and apply the facts to your car and locomotive springs. You are dealing with the same material, it has the same properties, the same forces are at work, and the same results will be had in greater or less degree. Possibly if you consider it seriously, you will conclude that it will be worth while for you to be careful in the manipulation of the springs which you wish to have carry your engines and cars in safety.

TESTING.

Testing of springs is probably well understood and need not be enlarged upon to any great length. All springs are made higher than the finished height to allow for the initial set, which occurs when they are first closed down. This is necessary, because if the temper were left so high that they would not set they would nearly all break, either in the test or in a very short time in service.

It is important in testing that springs be held down solid for a few minutes to allow for lag. A spring may be in a state of unstable equilibrium and endure a quick closing and release without setting too low if soft, or breaking if too hard, and then soon fail in service. This condition can be detected by holding it down solid for a few minutes, giving the necessary time for the strains to develop.

The United States government required springs for mortar carriages to be held down solid for 6 hours. This is just as unreasonable as not to hold them down at all. It is not on record that any spring broke after the first five minutes, but the holding them down for a few minutes under a heavy pressure is important.

CHEMISTRY.

While it is not well, as a general rule, to specify a given chemical composition and a physical test, unless the engineer is a very expert steel maker, it certainly was wise to fix a reasonable maximum of allowable phosphorus, sulphur, silicon and manganese, and a reasonable range of carbon. The effect of these elements is well known and excess can be guarded against, as it has been in the standards now adopted by all careful railroads, without any excessive cost or trouble to the manufacturers. It is assumed, of course, and properly, that if the chemistry is correct, the physical condition good, and the sizes are accurate, the steel maker's responsibility ceases, and as a general thing the rule works well, but it has its exceptions.

Not long ago a prominent spring maker received several carloads of steel which was well within the chemical limits, was sound, and rolled accurately. Upon attempting to work it into springs, the blanks nearly all broke in the process of forming. The steel was excessively red short and it was returned to the maker. The cause of this was back of the engineer and chemist, at a point probably impossible to reach by specification, except to claim the right to test for red shortness, and this should be done. There can be little doubt that the trouble was due to excess of oxygen, an element that cannot well be determined by ordinary analysis. That an excess of oxygen will produce excessive red shortness is beyond dispute.

After many years of analyzing and experimenting by Prof. John W. Langley, supplemented by many tests in the shop, to locate if possible the cause of the difference in strength in the tempered condition between Bessemer, open hearth, and crucible steels of practically even composition, the conclusion was reached that the cause was to be found in the difference in the quantities of oxygen, nitrogen, and hydrogen found in the steels. In Bessemer steel great quantities of these elements are blown through the mass. In the open hearth great quantities flow over the surface of the steel for hours and much is absorbed. In the crucible, only the amount that is in the pot or that may pass through the sides can get into the steel.

That these elements make a great difference is easily observed when a crucible happens to become uncovered during the melting, as sometimes occurs. If a hundred ingots be topped and set up for inspection, and only one has been exposed to flame by the crucible becoming uncovered, the inspector will notice it immediately, mark it "gas," and relegate it to the scrap heap. There is no good reason apparent why an atom of oxygen, nitrogen, or hydrogen may not be as potent as an atom of phosphorus or silicon, and they are all present in greater or less quantity. Prof. Langley's conclusion was that oxygen is the head devil. The writer held to nitrogen for a long time as his pet mischief maker, but it seems probable that Langley is more nearly correct. These remarks are not meant to belittle Bessemer or open hearth steel in any way. Their great merits and usefulness are too well established to leave them open to criticism.

The trouble is not in the method; it is in the man. Given the best material that the world can produce and it will not make good crucible steel if it is not melted properly, and no subsequent treatment will make a badly melted ingot a piece of good steel. It is the same with Bessemer and open hearth; bad blowing or bad melting cannot be cured by good chemistry.

The red short steel referred to doubtless came from a wild heat. The melter knew it, the roller knew it, and probably the superintendent knew it. They were all working for product, and they knew how to work that steel into pretty bars; but the spring maker did not know how to work it into springs, and it is probably well for his employers that he did not know.

THE STEEL MAKER MUST DO HIS WORK RIGHT.

We have now covered the ground that belongs properly to the engineer, the spring maker, and the inspector, and have tried to show how the work should be done, how to detect errors and how to correct them. This brings us back to the steel maker and out of the domain of the steel users. All steel is made good or bad in the crucible, the open hearth furnace, or the Bessemer converter. If the steel is good there can be no excuse for bad springs, and if the steel is not made good by good melting or blowing, it cannot be made good by any subsequent treatment. The matter rests, then, with the steel maker, because it will not do for the engineers or inspectors to attempt to regulate shop practice unless they are ready to assume all of the consequences.

During the latter part of the Civil War the government sent construction officers to the gun foundries. These gentlemen were to see that the right kind of iron was used and to see the guns cast. They did see that the iron of the recognized standard brands was put into the furnaces and it is needless to say that they did not know anything about its quality. They also saw the guns cast. This occurred after noon, and sometimes when the furnaces were slow they got in a hurry to go away and would say it was time to cast the guns. The answer always was, "All right; give us a written order to cast the gun, you agreeing to accept the result, and we will cast at any time you wish." The reply followed, "No, you must submit the gun to all regular tests, of course." And the argument ended, "Very well, we are responsible. We will use our own judgment until the gun is submitted for inspection." The same rule must apply to any manufacturer. If he is to be held responsible, he must not be interfered with in his management.

A good melter, of sound judgment and correct eye, knows exactly what he is doing and precisely what he will get. There is no pyrometer or spectroscope that is equal to a well-trained eye to inform one what is going on, and it is doubtful if any machine will ever be invented that will be as useful as a good eye. All that the steel user can do is to plead for good work and be willing to pay a decent price for it. The rush and drive in the mills, the keen, fierce competition of different manufacturers and lively salesmen, and the desire of the purchasing agent to keep down costs, are potent factors for poor work. The engineer wants the best he can get for his purpose, and he often finds that these factors have placed him "between the devil and the deep sea."

It is hoped that what has been said will lead properly to the conclusion that nothing has been suggested that will cost anybody one cent. It is meant only as a plea for honest effort, reasonable care, and close attention to every detail. These will result in general satisfaction, and any other course will lead to disaster.

ELECTROLYTIC SYNTHESIS OF SUGARS.

SINCE Woehler broke down the boundary line between organic and inorganic chemistry in 1828, by preparing urea, only known until then as a secretion of the animal system, the distinction between organic and inorganic compounds has gradually become a mere matter of convenience. Organic chemistry is essentially the chemistry of carbon compounds. As long as acetylene was prepared from alcohol or alcohol derivatives, it used to be classed with organic compounds, although it was known that hydrogen and carbon could be made to combine directly to acetylene. When we learned to manufacture, in the electric furnace, calcium carbide, which on decomposition with water yields acetylene in the easiest manner—too readily almost, in fact—acetylene passed into text-books of inorganic chemistry. The many remarkable syntheses of organic compounds worked out in recent decades, by systematic researches often extending over years, demonstrate that the chemist, though he does not pretend to have any real insight into the constitution of his compounds, has certainly mastered some secrets of constructive chemistry, if that term be permitted. Yet the very fact that most of these syntheses are very elaborate, and accomplished only with the aid of somewhat violent reactions, prevents the layman from seeing in such synthetical preparations any possible parallel to the methods by which nature works. Now we read that various kinds of sugar, capable of fermentation and optically active in the saccharimeter, have been obtained simply by electrolyzing water which was saturated with carbonic acid gas. Such an observation seems to bring us nearer to plant-life phenomena, since the plant builds up its body to a large extent by inhaling carbonic acid from the atmosphere.

The experiments in question have been made by Julius Walther, of St. Petersburg, and have been described in the Chemiker Zeitung, of August 16 and October 18, 1902. The chief interest of the novel experiments lies in their great simplicity. Walther starts from carbonic acid, generated from marble and hydrochloric acid and passed through water. Finding that current density is of great importance, he applies as anodes brushes of platinum wire 0.2 millimeter in diameter, the wire ends being all at equal distances from the cathodes. The cathodes have a very large surface and are made of platinum, silver, mercury, iron, etc., and by preference of clay, aluminium silicates. A red clay, containing some ferrous oxide, is further mixed with the oxide Fe_3O_4, or with carbon, or with both, and the mass is smeared on iron wire gauze, yielding a cathode of high resistance. A clay pot serves as diaphragm, and the anode compartment is sometimes heated with the aid of a small incandescence lamp, so that the temperature of the anode solution remains about 5 deg. C. higher than that of the cathode solution. The experiments have been conducted in two parallel series. In the first, the solution of carbonic acid gas in water is alone used; in the second, certain salts, chiefly ammonium sulphate or phosphate, and also vegetable albuminoids, were added. The results did not differ in principle, though they depend much on circumstances. We will chiefly refer to the experiments in which no additions were made to the water and CO_2.

The electrolysis commences, when the water is saturated with carbonic acid, with currents of 2 volts. The tension and strength of the current are then raised by steps, by increasing the cathode surface, heating the anode compartment, and in other ways. Oxalic acid first makes its appearance when the current intensity is 0.75 ampere. Then tartaric acid is formed, and soon citric acid, the latter, when the current meters indicate 4 volts and 2.25 amperes. The general conditions favorable for the formation of citric acid being maintained and the current slowly raised. Walther then noticed the appearances of carbohydrates at 5 volts and 3 amperes—fruit sugar first, finally grape sugar. The two memoirs quoted go very fully into the chemistry of the compounds, and the experimental accounts impress the reader as records of thorough, conscientious and competent work. Some of the many sugars known reduce Fehling's solution (alkaline copper sulphate) directly, and are capable of direct fermentation, other sugars not; these differences were observed. Most sugar solutions turn the plane of polarization. The rotary powers of Walther's sugars were not quite so high as they should be; but the isolation of pure products is not easy in experiments of this kind, and the great and striking novelty is that optically-active substances have been prepared, and, moreover, in such a remarkably simple way. It does not detract from Walther's merit that Le Royer had already obtained formic acid by electrolysis of aqueous carbonic acid solutions, and that Kekulé had electrolytically produced an optically active sugar, starting from tartaric acid. We need not further discuss the chemical side of the investigation, but must point out, to explain Walther's line of argument, that his products become richer and richer in carbon as current and potential rise. Oxalic acid has the formula $C_2H_2O_4$; tartaric acid, $C_4H_6O_6$; citric acid, $C_6H_8O_7$; the carbohydrates, $C_6H_{12}O_6$.

Walther regards the phenomena essentially as oxidation and reduction processes, and in this respect he is in agreement with most electro-chemists. That the electric current affords very convenient means of bringing about certain reductions and oxidations which must proceed under that careful control which the regulation of current potential, intensity, concentration, temperature, etc., in the electrolytic cell enables us to maintain, has long been recognized; and electrolytic processes are more widely applies, especially in organic chemistry, probably than is generally believed. Chemical manufacturers are not very communicative. But Walther goes very much further. Electricity, he argues, is a heat phenomenon. Chemical reduction is characterized by a fixation of hydrogen or a splitting off of oxygen, and equivalent to absorption of heat. Chemical oxidation, on the other hand, is characterized by a loss of hydrogen or a combination with oxygen, and equivalent to a loss of heat. This is not altogether novel. But Walther introduces—in addition to iron, which has long been known as a most active oxygen carrier—hydrogen peroxide, which acts both as a reducing and an oxidizing agent, according to circumstances, in order to explain many reactions; and he builds up a new kind of heat balances, to account not only for chemical and physical phenomena, but for life manifestations in general. We cannot follow him in his speculations. But his arguments certainly set us thinking, and we have long since entered upon a stage where the boundary line between the living and notliving, the animal and the vegetable kingdom on the one side, and the mineral kingdom on the other, becomes shadowy.

We want a certain quantity of heat to dissolve a salt, and until the solution is completed and equilibrium is restored, certain manifestations of energy will be going on. The apparent result of a reaction may be heat or cold; heat anyhow enters in some way, and a certain amount of heat is characteristic of any mechanical, physical, or chemical phenomenon. So it is in life processes. The animal system works at a certain normal temperature, which, though on the whole remarkably constant and independent of the quantity and quality of the food, may yet be powerfully influenced by certain medicines. Physiological chemistry has not yet reached an advanced stage. But drugs have synthetically been prepared in order to produce certain effects, and the effects aimed at have been realized. The presence of calcium salts favors these electrolytic syntheses of Walther noticeably. We have ascertained further that the small quantity of iron contained in our blood plays a most important part, which the organic chemist in his laboratory, at Oxford and elsewhere, has traced through many complicated reactions.

Nobody wonders that we should be able to stimulate and to arrest life, both by brute violence and by harmless-looking drugs; we find mechanical analogies in the action of certain poisons. But we cannot produce life, it is objected. Capability of interfering with life does not imply possibility of calling forth life. It does not. Yet the germ does not any more develop under unsuitable circumstances than chemical elements will interact when the proper conditions are absent. Some germs are exceedingly perishable; certain bacilli have been kept in liquid air—which should destroy all life, we fancy—without losing any of their vitality. Argon is very indifferent and sluggish under all conditions. The chemist has good reasons for regarding nitrogen as not much less indifferent. It requires strong spark discharges to force nitrogen into combination with oxygen. Yet organic chemistry teems with interesting nitrogen compounds, and nitrogen is an indispensable constituent of the albuminoids which appear to be characteristic of all forms of life. How do some plants manage to fix nitrogen? With the aid of certain bacteria which produce little tumors on the roots of plants, chiefly of the pea family. These tumors were considered symptoms of some disease. We have now begun to cultivate the respective bacteria and to infect poor soils, in which peas would not thrive, with them, and fine crops are reaped. The technical chemist has still much to learn about the conversion of nitrogen into nitrates, and the most recent investigations render it, indeed, doubtful whether the chief part in this assimilation of nitrogen by the plant is played by bacteria, or by the soil, or by the iron contained in the soil. Bonnema demonstrates that the common rust spots, which we find in the linen we wear, tend to corrode, because the iron oxide is, in the wet state, capable of oxidizing atmospheric nitrogen to nitrite. A similar and conceivably less slow process may go on in the soil, whose iron would then be as indispensable to plant life as the bacteria of Winogradsky and Beijerinck. That would mean that it is, in this case, as difficult to discriminate between an organic phenomenon and a merely chemical process as some scientists believe it to be to settle whether the powerful fermentations are produced by the action of organized living ferments or of dead enzymes. The chemist is only too well aware of the strange influences exercised by traces of impurities in which nobody suspects any vital forces. Sodium metal is apparently dead when immersed in petroleum, but becomes extremely vital in the presence of a drop of water; then it perishes rapidly. The resulting compound bears no more resemblance to the elements than the plant does to the germ, nor do the beautiful zeolitic crystals resemble the basaltic rock in and from which they grow at their slow rate in infinite variety, to decay again. And we must, after all, not forget that some of our violent laboratory reactions represent only energy manifestations characteristic of favorable conditions. Hydrogen gas and oxygen gas, every schoolboy has satisfied himself, will not combine unless a spark or a flame start the reaction. Nevertheless they do combine in the absence of either, and, though the process be exceedingly slow, the final heat balance is the same, and in the case of hydrogen and chlorine a ray of light will suffice to produce an explosion.

That metals and metalloids are by no means insensitive to impulses which, a few years ago still, were not supposed to affect them in the least, is now fully understood. If they seem to respond electrically as a rule, that is only because we have perfected our electrical instruments so highly. We used to puzzle over the marvelous fact that masses of strong scents, of absolutely inappreciable weight, are able to affect our nerves. We now wonder equally how it is possible that quantities of radium, which are far too small even for our wonderfully delicate spectroscopic tests, can act so powerfully. Individuality, perhaps, remains the most difficult attribute of life to conceive. It sounds absurd to speak of the individuality of a piece of wire; yet the engineer understands quite well now that he has to reckon with the history of that wire. The individuality ceases to exist with destruction. We do not expect that we shall be able to discern the past history of a piece of steel once more, after the steel has been transformed into a sulphate and reduced to metal and drawn out to wire again. But we do not know, and we are equally ignorant concerning our own individuality.—Engineering.

SEALING WAX.

THE Hindoos from time immemorial have possessed lac, and were long accustomed to use it for sealing manuscripts, long before it was known in Europe. It was first imported from the East into Venice and then into Spain, in which country sealing wax became the object of a considerable commerce to other countries under the name of Spanish wax.

If shellac be compounded into sealing wax, immediately after it has been separated by fusion from the palest qualities of stick or seed lac, it then forms a better and less brittle article than when the shellac is fused a second time. Hence, sealing wax prepared in the East Indies deserves a preference over what can be made in other countries, where the lac is not indigenous. Shellac can be restored in some degree, however, to a plastic and tenacious state by melting it with a very small portion of gum thus or paraffin wax. The palest shellac should be selected for bright-colored sealing wax, the dark kind being reserved for black.

The following formula may be followed for making red sealing wax: Take 4 pounds of shellac, 1 pound of Venice turpentine, and 3 pounds of vermilion. Melt the lac in a copper pan suspended over a clear charcoal fire, then add the turpentine slowly to it, and soon afterward add the vermilion, stirring briskly all the time of mixing with a rod in either hand. In forming the round sticks of sealing wax, a certain portion of the mass should be weighed while it is ductile, divided into the desired number of pieces, and then rolled out upon a warm marble slab by means of a smooth wooden block like that used by apothecaries for rolling a mass of pills.

The oval and square sticks of sealing wax are cast in molds, with the above compound, in a state of fusion. The marks of the lines of junction of the mold box may be afterward removed by holding the sticks over a clear fire, or passing them over a blue gas flame. Marbled sealing wax is made by mixing two, three, or more colored kinds together while they are in a semi-fluid state. From the viscidity of the several portions their incorporation is left incomplete, so as to produce the appearance of marbling. Gold sealing wax is made simply by adding gold chrome instead of vermilion into the melted resins. Wax may be scented by introducing a little essential oil, essence of musk, or other perfume. If 1 part of balsam of Peru be melted along with 99 parts of the sealing wax composition, an agreeable fragrance will be exhaled in the act of sealing with it. Either lamp black or ivory black serves for the coloring matter of black wax. Sealing wax is often adulterated with rosin, in which case it runs into thin drops at the flame of a candle.

The following formulæ are good:

Red (1).—4 ounces Venetian turpentine, 6 ounces shellac, ¾ ounce rosin, 1¼ ounce vermilion.

Red (2).—Venice turpentine and shellac like No. 1; rosin and vermilion, each 1¼ ounces; magnesia, ½ ounce.

Red (3).—4 ounces Venice turpentine, 5½ ounces shellac, 1½ ounce rosin, 1¼ ounce vermilion, 1 ounce scarlet chrome.

Fine Black.—4½ ounces Venetian turpentine, 9 ounces shellac, ½ ounce rosin; lampblack mixed with oil of turpentine, as much as required.

Black.—4 ounces Venetian turpentine, 8 ounces shellac, 3 ounces rosin; lampblack and oil of turpentine as required to color it.

Yellow.—2 ounces Venetian turpentine, 4 ounces shellac, 1½ ounces pale rosin, ¾ ounce chrome yellow, 1¼ drachms magnesia and oil of turpentine.

Dark Brown.—4 ounces Venetian turpentine, 7½ ounces shellac, 1½ ounces brown English, 1 ounce magnesia.

Brown.—4 ounces Venetian turpentine, 7 ounces

shellac, 3 ounces rosin, 1¼ ounces English umber, 1 ounce ocher.

Light Brown.—4 ounces Venetian turpentine, 7½ ounces shellac, 1 ounce brown earth, ½ ounce red oxide, ½ ounce each prepared chalk and magnesia.

Light Brown.—4 ounces Venetian turpentine, 7½ ounces shellac, 3 ounces rosin, 1½ ounces English umber, ¼ ounce red oxide, 1 ounce each washed chalk and magnesia.

Dark Blue.—3 ounces Venetian turpentine, 4 ounces shellac, 1 ounce rosin, 1 ounce Prussian blue, ½ ounce magnesia.

Green.—2 ounces Venetian turpentine, 4 ounces shellac, 1¼ ounces rosin, ½ ounce chrome yellow, ¾ ounce Prussian blue, 1 ounce magnesia.

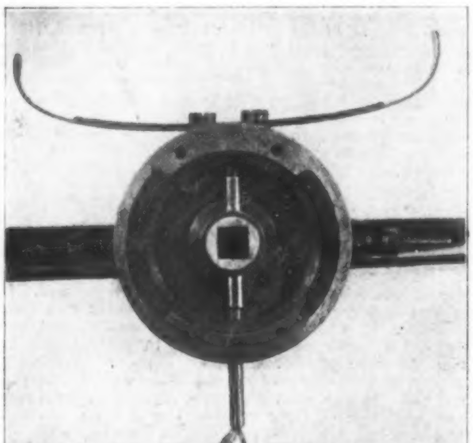
Carmine Red.—1 ounce Venetian turpentine, 4 ounces shellac, 1 ounce rosin, colophony, 1¼ ounces, Chinese red, 1 drachm magnesia, with oil of turpentine.

Gold.—4 ounces Venetian turpentine, 8 ounces shellac, 14 sheets of genuine leaf gold, ½ ounce bronze, ½ ounce magnesia, with oil of turpentine.—Oils, Colors, and Drysalteries.

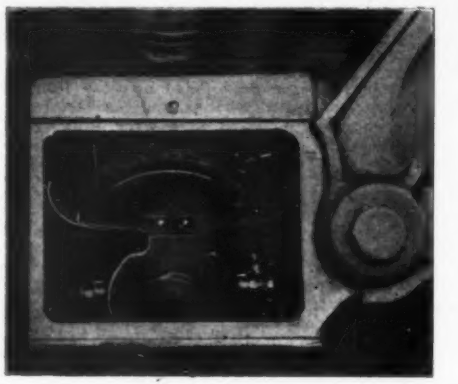
THE DETTMAR ELECTRIC SPEED INDICATOR.*

Mr. Dettmar has invented, and the Electricitäts-actien Gesellschaft vorm. W. Lahmer & Co., of Frankfort-on-the-Main, has constructed, an electric tachymeter, or speed indicator, designed to remedy the inadequacy and numerous defects of the mechanical tachymeters that have been employed up to the present for measuring the speed of vehicles that have a rectilinear motion, such as railway cars, street cars, automobiles, etc.

The principle of the apparatus is that of measuring either the power or tension of an electric current that varies with the speed of the vehicles. The speed of a vehicle having a rectilinear motion is easy to determine, since it depends directly upon the number of revolutions made by the wheels. To do this there is nothing more simple than to secure a dynamo to the axles of the wheels and calculate the number of revolutions from the readings of a voltmeter connected with the generator. In fact, the tension increases in a dynamo with the increase in the number of revolutions. The inventor and manufacturers, however, abandoned this method, because it did not permit them to obtain all the simplicity of construction desirable.



THE INTERRUPTER OPEN.



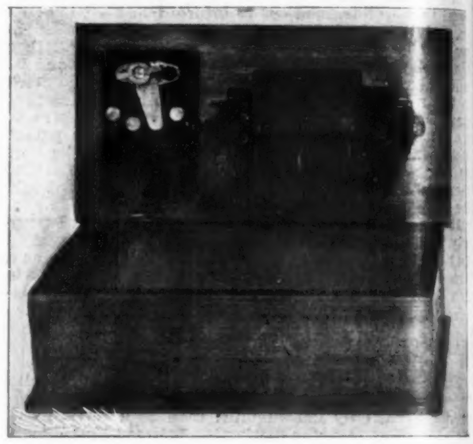
INTERRUPTER OF THE DETTMAR TACHYMETER MOUNTED IN AXLE-BOX OF TENDER.

Before going further, we must remark that it is in no wise indispensable to have recourse to the complications of a dynamo, for it suffices to fix to the axle, at right angles with it, a rectilinear magnet of which the poles pass alternately in front of a coil connected with a voltmeter. The magnet and coil may be of small dimensions if the voltmeter is very sensitive.

The inventor and manufacturers therefore entered upon a path that they believed to be more practical and tried various methods of carrying out their ideas. One of these was based upon the principle that "If an ammeter, a self-induction coil, and an alternator be put in circuit, the intensity for a given electromotive force will diminish when the frequency increases." The same principle will be verified if an interrupter be substituted for the alternator. A tachymetric arrangement based upon this principle may be devised without any trouble. All that has to be done is to connect the interrupter with the axle in such a way that it shall make the same number of revolutions, and, consequently, produce a number of interruptions that will vary with the speed of the vehicle. This method did not appear satisfactory to the inventor and manufacturers because the deflection of the indicating needle diminishes with the increase of the speed instead of augmenting as it ought to. They therefore had recourse to a second method designed to remedy this inconvenience by the use of a differential ammeter.

This apparatus includes two windings arranged in such a way as to repel each other. One of the coils is connected in an invariable manner with the source of the current that is to be interrupted, while the other is put in circuit with the interrupter and self-induction coil. The windings are such that in the normal state, that is to say, while the vehicle is at rest, the two coils are at their maximum distance apart. When the train begins to move, one of the two opposite forces remains constant, while the other diminishes in measure as the frequency of the interruptions increases, that is to say, in measure as the speed of the vehicle increases. The result is that the constant force will act with so much the greater intensity in proportion as the opposing force diminishes, and, as a consequence, the needle will deviate so much the more in proportion as the speed is greater. Laboratory experiments, however, showed that the indications of the ammeter did not increase exactly with the number of revolutions, and the method was therefore not satisfactory.

The idea then occurred to use a transformer. The primary comprised, in addition to the self-induction coil, an interrupter connected with the axle and source of energy; and the secondary, a voltmeter. Instead of measuring the current in the primary circuit, the tension was measured in the secondary. This, however, did not prove satisfactory. In fact, since the tension at the terminals of the primary was constant, whatever was the number of revolutions or interruptions, the tension at the secondary had also to be constant. It was a question, therefore, of causing the tension to vary in the primary. Such a result was obtained by interposing a resistance. In fact, when the number of revolutions increases, that is to say, when the intensity of the current diminishes, an ever-decreasing part of the tension of the primary will be destroyed in the resistance; a portion, which increases with the number of revolutions, therefore reaches the extremities of the primary coil and becomes transformed there, that is to say, that in measure as the number of interruptions increases, the tension becomes elevated in the secondary coil. However, it still remained to withdraw the primary tension from the variations due to external circumstances and to the nature of the accumulators. In order to do this, recourse was had to quite a simple artifice. Electric conductors, as is well known, have a resistance that increases in one kind of conductor and diminishes in another kind, when they are heated. If we arrange a conductor of one kind and a conductor of the other in series, to the changes of tension that will be produced in one as a consequence of the variations in the intensity of the currents, there will correspond inverse changes in the other. Such variations of contrary direction will neutralize each other. Such is, in principle, the system adopted. For an application upon railways, one difficulty still presents itself, and that



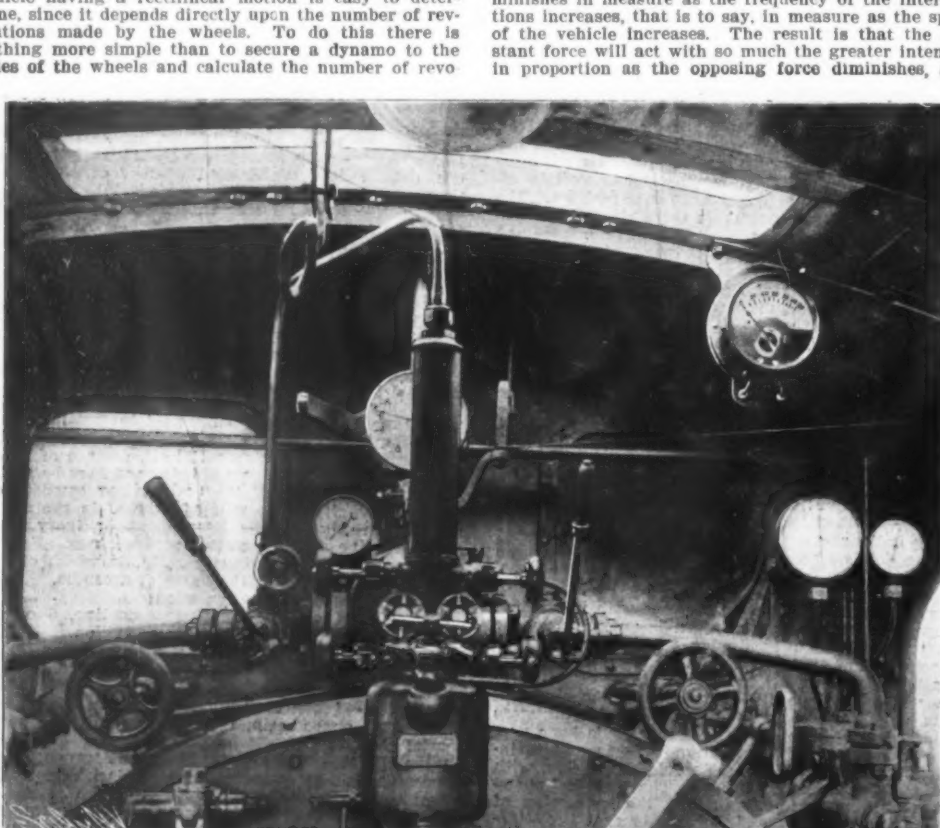
BOX CONTAINING THE TRANSFORMER, THE RESISTANCE, AND THE REGULATING DEVICES OF THE DETTMAR TACHYMETER.

is the necessity of an independent source of a continuous current. In the experiments made at Frankfort upon a locomotive, there was used a set of dry batteries of which the normal tension was 57 volts. The batteries were placed upon the tender; the interrupter in the forward grease-box of the tender; the transformer (inclosed in a wooden box) in the engineman's cab; the tachymeter, proper, above the boiler; a bipolar circuit-breaker upon the tender; and the conductor in great part in flexible steel tubes. In order to prevent errors due, after a certain time, to the wear of the wheels, there was added to the apparatus a regulating apparatus that permitted of very simply increasing the interposed resistance and of reducing the tension at the terminals of the primary. The interrupter was constructed with particular care in order to assure its perfect operation, to have it occupy but small space, and to render it as simple and as easily inspected as possible.

The circuit-breaker is composed of a box, closed by an easily removable cover, and in the interior of which revolves a pin screwed into the side of the axle. This pin receives the pressure of two copper plates, which are held against it by springs. The friction surface is interrupted at four places by grooves. It consists of two opposite and insulated segments, through which the electricity enters and exits, and of two other segments which complete the circle, but serve no other purpose. When the pin rubs on one pair of segments, the current is closed, and, when it touches the other, it is interrupted.

The transformer is provided with two primary and two secondary windings. In the same box is placed the interposed resistance and the regulating mechanism of which we have spoken. The measuring apparatus consists of a wire voltmeter heated by the current. One of our illustrations represents it mounted in the engineer's cab. It is protected against shocks by a rubber band interposed between its posterior face and the wall. The sensitiveness of the apparatus is, according to the inventor, very great, and its accuracy extreme. It has operated, without giving rise to any difficulties, since the 19th of September of last year.

The Dettmar tachymeter might also, we think, find a wide field of application upon electric street cars. We should here have the advantage of being able to utilize the current that is right at hand. Some improvement might easily be made in it for such a purpose, and these the manufacturers have under consideration. The apparatus might also be employed in the navy and the merchant marine. It might perform the rôle of a revolution counter and permit, without any trouble, of distinguishing the backward and forward running of the engine through the addition of two small plates provided with appropriate inscriptions and actuated, now one and now the other, accord-



THE DETTMAR TACHYMETER MOUNTED IN A LOCOMOTIVE CAB.

* Specially prepared for the Scientific American Supplement.

ing to the direction of the running. The apparatus of the various engines, especially upon war vessels, might be advantageously united in the pilot house.

Finally, the apparatus is capable of rendering valuable services in any installation of engines in which it is of importance to control and regulate the number of revolutions, such as in large electric central stations, and in subterranean pumping installations controlled electrically upon the floor of the mine.

THE UTAH "HOT-POTS."*

AT the eastern base of the great Wasatch range of mountains, and about 26 miles southeast from Salt Lake City, is a group of curious limestone formations known as the "hot-pots." There are some twenty of these, several of them dry, the larger number being active and containing considerable quantities of warm water, fed by springs underneath.

These "pots" have a form resembling that of a volcanic crater and are of all sizes, from that of a barrel up to a small mountain, the largest, known as "Ritter's hot-pot," being 80 feet in height and covering more than an acre of ground.

The hot-pots are located in the little agricultural town of Midway, and the water from two of the larger ones is used to supply small bath-houses, the temperature of the water remaining uniform during the entire year at from 90 to 95 deg. F.

The craters are formed by the deposition of calcium carbonate from the water, the resultant rock being of a somewhat porous but quite hard character. It is the common building material of the locality, both for houses and fences, while the lime produced by burning it is highly esteemed as of superior quality.

The craters all have nearly level rims, and with but one exception the inner surface slopes abruptly backward from the center, giving the visitor a feeling of alarm as to the stability of his footing. The walls vary greatly in thickness and taper gradually toward the top, where they are, in some cases, but a mere shell.

The water in the active pots varies in height according to the flow of the springs, there being occasional overflows with consequent further building up of the formation.

The great pot at Ritter's hotel, by all odds the most interesting of the group, is perfectly symmetrical on all sides, and previous to the tunneling of its base to tap the water from beneath, had a constant overflow. It requires three pipes of 3-inch internal diameter to carry the water from this spring to the adjacent bathing pools.

Although Ritter's hot-pot has a flat top over 200 feet across, the orifice in the center is but 20 feet in diameter, and has an irregular vertical shape, widening somewhat near the ground level.

The water in all the pots is strongly impregnated with carbonic acid, and bubbles of the gas may be seen continually rising from the center. The source of the flow is undoubtedly in the lofty mountains immediately west of the town, and to the presence of carbonic acid taken from decaying vegetable matter it owes its ability to dissolve so much of the limestone through which it percolates. Where it gets its high temperature is not so obvious, nor is the varying color of the water in two closely adjacent pots known as "Ink" and "Emerald" easily explainable, although the fact itself is probably due to the presence of certain minerals.

There are many millions of tons of the deposited limestone rock in the vicinity of the hot-pots, and in fact the town of Midway occupies a sort of bench built of it, several hundred feet higher than the beautiful Heber Valley which it overlooks.

It is probable that immense caverns exist in the mountains nearby whence the water has dissolved so great a quantity of the stone, but although there is much mining and prospecting in the neighborhood it is not known that anything of the sort has as yet been discovered.

By the erection of commodious hotels and bathhouses the place might be made a great summer resort, as the scenery and climate are magnificent. Access is easy by way of the branch road running to Heber, from Provo, on the main line of the Rio Grande Railroad, but it is little visited by tourists.

The great Ritter hot-pot is threatened with destruction by its owner, the sugar factory at Lehi having made an attractive offer for the limestone. Its removal would be a calamity indeed, for nothing approaching it in magnitude and character exists elsewhere in the country. CHARLES . RANDALL.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

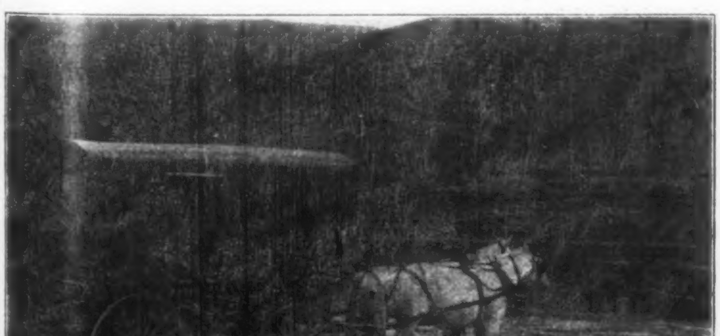
BIG HOT-POT, 80 FEET HIGH, COVERING AN ACRE.

RADIO-ACTIVE GAS FROM BATH MINERAL WATERS.

PROF. J. J. THOMSON has shown that the air extracted from Cambridge tap-water and from the waters of certain deep-level springs is mixed with a radio-active gas (Nature, vol. lxviii., p. 90). It appeared of special interest to determine whether such a constituent existed in the hot mineral springs of Bath. Samples of water direct from the King's Bath Spring have been examined at the Blythswood Laboratory, and have been shown to contain a radio-active gas in solution. In the first experiments the gas was expelled from a flask containing a liter and a half of water by boiling under a pressure of about half an atmosphere. The amount of gas obtained after passing through a number of drying tubes was small, as was shown by the fact that the pressure only altered by a few centimeters. Yet this was sufficient to produce a marked increase in the ionization in the testing vessel. The gas was also extracted from the water by exhausting the testing vessel and allowing a current of air to bubble through the water and a series of drying tubes into the vessel. In this case the ionization current increased from four to five times.

Whichever method was employed for introducing the gas into the testing vessel, it was found that the effect did not assume its full value instantaneously, but gradually increased to a maximum and then diminished. The activity reached a maximum in rather more than one hour after the admission of the gas. About half an hour later the activity had diminished to one-half the maximum value. Rutherford (Phil. Mag., v., p. 448, 1903) has observed a similar effect when the emanation from radium is introduced into a closed space. In this case the maximum activity is reached after five or six hours, and the activity decays to half value in 371 days. The gas from the Cambridge water lost from 5 to 10 per cent of its activity in twenty-four hours. The gas from the Bath water appears to be intermediate in character between the radium emanation and the Cambridge gas on the one hand, and the thorium emanation on the other. The activity of the thorium emanation diminishes to one-half in one minute.

If the therapeutic action of the Bath waters is due in any degree to the radio-activity of the gases con-



THE CRATER OF A HOT-POT.

LUKE'S HOT-POT.

UTAH "HOT-POTS."

tained in them, the fact that the activity of the gas now being investigated begins to decrease so soon after the gas has been liberated acquires special significance. The opinion is commonly held that the waters of various spas possess greater efficacy when used on the spot. It is probable that this opinion, though doubtless fostered by interested individuals, has some basis in fact, and it is possible that the underlying fact may here find an explanation.

Prof. Dewar has shown that the Bath waters contain helium. The presence of a radio-active and of an inert gas in the same water is of interest from the point of view of the possible transmutation of such elements.—H. S. Allen, in Nature.

ON ETHER AND GRAVITATIONAL MATTER THROUGH INFINITE SPACE.*

By Lord Kelvin.

NOTE ON THE POSSIBLE DENSITY OF THE LUMINIFEROUS MEDIUM AND ON THE MECHANICAL VALUE OF A CUBIC MILE†‡ OF SUNLIGHT.§

SECTION 1.—That there must be a medium forming a continuous material communication throughout space to the remotest visible body is a fundamental assumption in the undulatory theory of light. Whether or not this medium is (as appears‖ to me most probable) a continuation of our own atmosphere, its existence is a fact that cannot be questioned when the overwhelming evidence in favor of the undulatory theory is considered; and the investigation of its properties in every possible way becomes an object of the greatest interest. A first question would naturally occur, What is the absolute density of the luminiferous ether in any part of space? I am not aware of any attempt having hitherto been made to answer this question, and the present state of science does not in fact afford sufficient data. It has, however, occurred to me that we may assign an inferior limit to the density of the luminiferous value of sunlight as deduced in preceding communications to the Royal Society¶ from Pouillet's data on solar radiation and Joule's mechanical equivalent of the thermal unit. Thus the value of solar radiation per second per square centimeter at the earth's distance from the sun, estimated at 1,235 centimeter-grammes, is the same as the mechanical value of sunlight in the luminiferous medium through a space of as many cubic centimeters as the number of linear centimeters of propagation of light per second. Hence the mechanical value of the whole energy, kinetic and potential, of the disturbance kept up in the space of a cubic centimeter at the earth's distance from the sun** is

$$\frac{1235}{3 \times 10^{10}}, \text{ or } \frac{412}{10^{10}} \text{ of a cm.-gramme.}$$

Sec. 2.—The mechanical value of a cubic kilometer of sunlight is consequently 412 meter-kilogrammes, equivalent to the work of 1 horse power for five and four-tenths seconds. This result may give some idea of the actual amount of mechanical energy of the luminiferous motions and forces within our own atmosphere. Merely to commence the illumination of 11 cubic kilometers requires an amount of work equal to that of a horse power for a minute; the same amount of energy exists in that space as long as light continues to traverse it, and, if the source of light be suddenly stopped, must pass from it before the illumination ceases.†† The matter which possesses this energy is the luminiferous medium. If, then, we knew the velocities of the vibratory motions, we might ascertain the density of the luminiferous medium; or, conversely, if we knew the density of the medium, we might determine the average velocity of the moving particles.

Sec. 3.—Without any such definite knowledge we may assign a superior limit to the velocities and deduce an inferior limit to the quantity of matter by considering the nature of the motions which constitute waves of light. For it appears certain that the amplitudes of the vibrations constituting radiant heat and light must be but small fractions of the wave lengths, and that the greatest velocities of the vibrating particles must be very small in comparison with the velocity of propagation of the waves.

Sec. 4.—Let us consider, for instance, homogeneous plane polarized light, and let the greatest velocity of vibration be denoted by v; the distance to which a particle vibrates on each side of its position of equilibrium by A; and the wave length by λ. Then, if V denote the velocity of propagation of light or radiant heat, we have

$$\frac{v}{V} = 2\pi \frac{A}{\lambda};$$

and therefore if A be a small fraction of λ, v must also be a small fraction (2π times as great) of V. The same relation holds for circularly polarized light, since in the time during which a particle revolves once round in a circle of radius A, the wave has been propagated over a space equal to λ. Now, the whole mechanical value of homogeneous plane polarized light in an infinitely small space containing only particles sensibly in the same phase of vibration, which consists entirely of potential energy at the instants when the particles are at rest at the extremities of their excursions, partly of potential and partly of kinetic energy when they are moving to or from their positions of equilibrium, and wholly of kinetic energy when they are passing through these positions, is of constant amount, and must therefore be at every instant equal to half the mass multiplied by the square of the velocity which the particles have in the last-mentioned case. But the velocity of any particle passing through its position of equilibrium is the greatest velocity of vibration. This we have denoted by v; and, therefore, if p denote the quantity of vibrating matter contained in a certain space, a space of unit volume, for instance, the whole mechanical value of all the energy, both kinetic and potential, of the disturbance within that space at any time is $\frac{1}{2} pv^2$. The mechanical energy of circularly polarized light at every instant is (as has been pointed out to me by Prof. Stokes) half kinetic energy of the revolving particles and half potential energy of the distortion kept up in the luminiferous medium; and, therefore, v being now taken to denote the constant velocity of motion of each particle, double the preceding expression gives the mechanical value of the whole disturbance in a unit of volume in the present case.

Sec. 5.—Hence, it is clear that for any elliptically polarized light the mechanical value of the disturbance in a unit of volume will be between $\frac{1}{2} pv^2$ and pv^2, if v still denote the greatest velocity of the vibrating particles. The mechanical value of the disturbance kept up by a number of coexisting series of waves of different periods, polarized in the same plane, is the sum of the mechanical values due to each homogeneous series separately, and the greatest velocity that can possibly be acquired by any vibrating particle is the sum of the separate velocities due to the different series. Exactly the same remark applies to coexistent series of circularly polarized waves of different periods. Hence, the mechanical value is certainly less than half the mass multiplied into the square of the greatest velocity acquired by a particle, when the disturbance consists in the superposition of different series of plane polarized waves; and we may conclude for every kind of radiation of light or heat except a series of homogeneous circularly polarized waves, that the mechanical value of the disturbance kept up in any space is less than the product of the mass into the square of the greatest velocity acquired by a vibrating particle in the varying phases of its motion. How much less in such a complex radiation as that of sunlight and heat we cannot tell, because we do not know how much the velocity of a particle may mount up, perhaps even to a considerable value in comparison with the velocity of propagation, at some instant by the superposition of different motions chancing to agree; but we may be sure that the product of the mass into the square of an ordinary maximum velocity, or of the mean of a great many successive maximum velocities of a vibrating particle, cannot exceed in any great ratio the true mechanical value of the disturbance.

Sec. 6.—Recurring, however, to the definite expression for the mechanical value of the disturbance in the case of homogeneous circularly polarized light, the only case in which the velocities of all particles are constant and the same, we may define the mean velocity of vibration in any case as such a velocity that the product of its square into the mass of the vibrating particles is equal to the whole mechanical value, in kinetic and potential energy, of the disturbance in a certain space traversed by it; and from all we know of the mechanical theory of undulations, it seems certain that this velocity must be a very small fraction of the velocity of propagation in the most intense light or radiant heat which is propagated according to known laws. Denoting this velocity for the case of sunlight at the earth's distance from the sun by v, and calling W the mass in grammes of any volume of the luminiferous ether, we have the mechanical value of the disturbance in the same space, in terms of terrestrial gravitation units,

$$\frac{W}{g} v^2,$$

where g is the number 981 (measuring in C. G. S. absolute units of force) the force of gravity on a gramme. Now, from Pouillet's observation, we found in the last footnote on section 1 above, $\frac{1235 \times 46000}{V}$ for the mechanical value, in centimeter-grammes, of a cubic centimeter of sunlight in the neighborhood of the sun; and therefore the mass, in grammes, of a cubic centimeter of the ether, must be given by the equation,

$$W = \frac{981 \times 1235 \times 46000}{v^2 V}.$$

If we assume $v = \frac{1}{n} V$, this becomes

$$W = \frac{981 \times 1235 \times 46000}{V^3} \times n^2 =$$

$$\frac{981 \times 1235 \times 46000}{(3 \times 10^{10})^3} \times n^2 = \frac{20.64}{10^{22}} \times n^2 \text{gm.};$$

and for the mass, in grammes, of a cubic kilometer we have $\frac{20.64}{10^7} \times n^2$.

Sec. 7.—It is quite impossible to fix a definite limit to the ratio which v may bear to V; but it appears improbable that it could be more, for instance, than one-fiftieth for any kind of light following the observed laws. We may conclude that probably a cubic centimeter of the luminiferous medium in the space near the sun contains not less than 516×10^{-20} of a gramme of matter; and a cubic kilometer not less than 516×10^{-5} of a gramme.

Sec. 8.—November 16, 1899.—We have strong reason to believe the density of ether is constant throughout interplanetary and interstellar space. Hence, taking the density of water as unity according to the convenient French metrical system, the preceding statements are equivalent to saying that the density of ether in vacuum or space devoid of ponderable matter is everywhere probably not less than 5×10^{-18}.

Hence the rigidity (being equal to the density multiplied by the square of the velocity of light) must be not less than 4,500 dynes* per square centimeter. With this enormous value as an inferior limit to the rigidity of the ether, we shall see in an addition to Lecture XIX. that it is impossible to arrange for a radiant molecule moving through ether and displacing ether by its translatory as well as by its vibratory motions, consistently with any probable suppositions as to magnitudes of molecules and ruptural rigidity-modulus of ether; and that it is also impossible to explain the known smallness of ethereal resistance against the motions of planets and comets, or of smaller ponderable bodies, such as those we can handle and experiment upon in our abode on the earth's surface, if the ether must be pushed aside to make way for the moving body through it. We shall find ourselves forced to consider the necessity of some hypothesis for the free motion of ponderable bodies through ether, disturbing it only by condensations and rarefactions, with no incompatibility in respect to joint occupation of the same space by the two substances.†

Sec. 9.—I wish to make a short calculation to show how much compressing force is exerted upon the luminiferous ether by the sun's attraction. We are accustomed to call ether imponderable. How do we know it is imponderable? If we had never dealt with air except by our senses, air would be imponderable to us; but we know by experiment that a vacuous glass globe shows an increase of weight when air is allowed to flow into it. We have not the slightest reason to believe the luminiferous ether to be imponderable. [November 17, 1899.—I now see that we have the strongest possible reason to believe that ether is imponderable.] It is just as likely to be attracted to the sun as air is. At all events the onus of proof rests with those who assert that it is imponderable. I think we shall have to modify our ideas of what gravitation is, if we have a mass spreading through space with mutual gravitations between its parts without being attracted by other bodies. [November 17, 1899.—But is there any gravitational attraction between different portions of ether? Certainly not, unless either it is infinitely resistant against condensation, or there is only a finite volume of space occupied by it. Suppose that ether is given uniform spread through space to infinite distances in all directions. Any spherical portion of it, if held with its surface absolutely fixed, would by the mutual gravitation of its parts become heterogeneous; and this tendency could certainly not be counteracted by doing away with the supposed rigidity of its boundary and by the attraction of ether extending to infinity outside it. The pressure at the center of a spherical portion of homogeneous gravitational matter is proportional to the square of the radius, and therefore, by taking the globe large enough may be made as large as we please, whatever be the density. In fact, if there were mutual gravitation between its parts, homogeneous ether extending through all space would be essentially unstable unless infinitely resistant against compressing or dilating forces. If we admit that ether is to some degree condensable and extensible, and believe that it extends through all space, then we must conclude that there is no mutual gravitation between its parts, and cannot believe that it is gravitationally attracted by the sun or the earth or any ponderable matter; that is to say, we must believe ether to be a substance outside the law of universal gravitation.]

Sec. 10.—In the meantime it is an interesting and definite question to think of what the weight of a column of luminiferous ether of infinite height resting on the sun would be, supposing the sun cold and quiet, and supposing for the moment ether to be gravitationally attracted by the sun as if it were ponderable matter of density 5×10^{-18}. You all know the theorem for mean gravity due to attraction inversely as the square of the distance from a point. It shows that the heaviness of a uniform vertical column AB of mass w per unit length and having its length in a line through the center of force C, is

$$\frac{mw}{CA} - \frac{mw}{CB}; \text{ or } \frac{mw}{CA} \text{ if CB} = \infty,$$

where m denotes the attraction on unit of mass at unit distance. Hence writing for mw/CA, $mwCA/CA^2$, we see that the attraction on an infinite column under the influence of a force decreasing according to inverse square of distance is equal to the attraction on a column equal in length to the distance of its near end from the center and attracted by a uniform force equal to that of gravity on the near end. The sun's radius is 697×10^8 centimeters, and gravity at his surface is 27 times‡ terrestrial gravity, or say 27,000 dynes per gramme of mass. Hence the sun's attraction on a column of ether of a square centimeter section, if of density 5×10^{-18}, and extending from his surface to infinity, would be 9.4×10^{-5} of a dyne, if ether were ponderable.

Sec. 11.—Considerations similar to those of November, 1899, inserted in Section 9 above, lead to decisive proof that the mean density of ponderable matter through any very large spherical volume of space is smaller the greater the radius, and is infinitely small for an infinitely great radius. If it were not so a majority of the bodies in the universe would each experience infinitely great gravitational force. This is a short statement of the essence of the following demonstration:

Sec. 12.—Let V be any volume of space bounded

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* Reprinted from the London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science [sixth series], August, 1901, pp. 161-177. [This is an amplification of Lecture XVI., Baltimore, October 15, 1884, now being prepared for print in a volume on Molecular Dynamics and the Wave Theory of Light, which I hope may be published within a year from the present time.]

† Note of December 22, 1892.—The brain-wasting perversity of the insular inertia which still condemns British engineers to reckonings of miles and yards and feet and inches and grains and pounds and ounces and acres is curiously illustrated by the title and numerical results of this article as originally published.

‡ October 13, 1899.—In the present reproduction, as part of my Lecture XVI., of Baltimore, 1884, I suggest cubic kilometer instead of "cubic mile" in the title, and use the French metrical system exclusively in the article.

§ From Edin. Royal Soc. Trans., vol xxi., part i., May, 1854; Phil. Mag., ix., 1854; Comptes Rendus, xxxix., Sept., 1854; Art. LXVII. of Math. and Phys. Papers.

‖ October 13, 1899.—Not so now. I did not in 1884 know the kinetic theory of gases.

¶ Trans. R. S. E.; Mechanical Energies of the Solar System; republished as Art. LXVI. of Math. and Phys. Papers.

** The mechanical value of sunlight in any space near the sun's surface must be greater than in an equal space at the earth's distance in the ratio of the square of the earth's distance to the square of the sun's radius—that is, in the ratio of 46,000 to 1 nearly. The mechanical value of a cubic centimeter of sunlight near the sun must, therefore, be

$$\frac{1235 \times 46000}{3 \times 10^{10}}, \text{ or about .0019 of a cm.-gramme.}$$

†† Similarly we find 4,140 horse power for a minute as the amount of work required to generate the energy existing in a cubic kilometer of light near the sun.

* See Math. and Phys. Papers, vol. iii., p. 522; and in the last line of table 4, for "$\rho > 10^{-23}$" substitute "$\rho < 10^{-23}$."

† See Phil. Mag., Aug., 1900, pp. 181-198.

‡ This is founded on the following values for the sun's mass and radius and the earth's radius: Sun's mass = 324,000 earth's mass; sun's radius = 697,000 kilometers; earth's radius = 6,371 kilometers.

by a closed surface S, outside of which and within which there are ponderable bodies; M the sum of the masses of all these bodies within S; and ρ the mean density of the whole matter in the volume V. We have

$$M = \rho V \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1).$$

Let Q denote the mean value of the normal component of the gravitational force at all points of S. We have

$$QS = 4\pi M = 4\pi \rho V \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2).$$

by a general theorem discovered by Green seventy-three years ago regarding force at a surface of any shape, due to matter (gravitational or ideal electric or ideal magnetic) acting according to the Newtonian law of the inverse square of the distance. It is interesting to remark that the surface integral of the normal component force due to matter outside any closed surface is zero for the whole surface. If normal component force acting inward is reckoned positive, force outward must of course be reckoned negative. In equation (2) the normal component force may be outward at some points of the surface S, if in some places the tangent plane is cut by the surface. But if the surface is wholly convex the normal component force must be everywhere inward.

Sec. 13.—Let now the surface be spherical of radius r. We have

$$S = 4\pi r^2;\ V = \frac{4\pi}{3} r^3;\ V = \frac{1}{3} rS \quad \ldots\ldots\ldots \quad (3).$$

Hence, for a spherical surface (2), gives

$$Q = \frac{4\pi}{3} r\rho = \frac{M}{r^2} \quad \ldots\ldots\ \ldots\ldots\ldots \quad (4).$$

This shows that the average normal component force over the surface S is infinitely great, if ρ is finite, and r is infinitely great, which suffices to prove Section 11.

Sec. 14.—For example, let

$$r = 150 \,.\, 10^6 \,.\, 206 \,.\, 10^3 = 3.09 \,.\, 10^{16} \text{ km.} \quad \ldots\ldots\ldots \quad (5).$$

This is the distance at which a star must be to have parallax one one-thousandth of a second; because the mean distance of the earth from the sun is 150,000,000 kilometers, and there are 206,000 seconds of angle in the radian. Let us try whether there can be as much matter as a thousand million times the sun's mass, or, as we shall say for brevity, a thousand million suns, within a spherical surface of that radius (5). The sun's mass is 324,000 times the earth's mass, and therefore our quantity of matter on trial is $3.24 \,.\, 10^{14}$ times the earth's mass. Hence if we denote by g terrestrial gravity at the earth's surface, we have by (4)

$$Q = 3.24 \,.\, 10^{14} \left(\frac{6.37 \,.\, 10^3}{3.09 \,.\, 10^{16}} \right)^2 g = 1.37 \,.\, 10^{-11} . g \quad \ldots . (6).$$

Hence if the radial force were equal over the whole spherical surface, its amount would be $1.37 \,.\, 10^{-11}$ of terrestrial surface-gravity; and everybody on or near that surface would experience an acceleration toward the center equal to

$$1.37 \,.\, 10^{-13} \text{ kms. per second per second} \quad \ldots . (7).$$

because g is approximately 1,000 centimeters per second or .01 kilometer per second per second. If the normal force is not uniform, bodies on or near the spherical surface will experience centerward acceleration, some at more than that rate, some less. At exactly that rate, the velocity acquired per year (thirty-one and a half million seconds) would be $4.32 \,.\, 10^{-6}$ kilometers per second. With the same rate of acceleration through five million years the velocity would amount to 21.6 kilometers per second, if the body started from rest at our spherical surface; and the space moved through in five million years would be $.17 \,.\, 10^{16}$ kilometers, which is only .055 of r (5). This is so small that the force would vary very little, unless through the accident of near approach to some other body. With the same acceleration constant through twenty-five million years the velocity would amount to 108 kilometers per second; but the space moved through in twenty-five million years would be $4.25 \,.\, 10^{16}$ kilometers, or more than the radius r, which shows that the rate of acceleration could not be approximately constant for nearly as long a time as twenty-five million years. It would, in fact, have many chances of being much greater than 108 kilometers per second, and many chances also of being considerably less.

Sec. 15.—Without attempting to solve the problem of finding the motions and velocities of the 1,000,000,000 bodies, we can see that if they had been given at rest* twenty-five million years ago distributed uniformly or nonuniformly through our sphere (5) of $3.09 \,.\, 10^{16}$ kilometers radius, a very large proportion of them would now have velocities not less than 20 or 30 kilometers per second, while many would have velocities less than that; and certainly some would have velocities greater than 108 kilometers per second; or if thousands of millions of years ago they had been given at rest, at distances from one another very great in comparison with r (5), so distributed that they should temporarily now be equably spaced throughout a spherical surface of radius r (5), their mean velocity (reckoned as the square root of the mean of the squares of their actual velocities), would now be 50.4 kilometers per second.† This is not very unlike what we know of the stars visible to us. Thus it is quite possible, perhaps probable, that there may be as much matter as a thousand million suns within the distance corresponding to parallax one one-thousandth of a second ($3.09 \,.\, 10^{16}$ kilometers). But it seems perfectly certain that there cannot be within this distance as much matter as 10,000,000,000 suns; because if there were we should find much greater velocities of visible stars than observation shows, according to the following tables of results and statements from the most recent scientific authorities on the subject.

[From the Annuaire du Bureau des Longitudes (Paris, 1901).]

Magnitude.	Name of Star.	Distance from earth in million million kilometers	Annual proper motions.	Parallax.	Velocities perpendicular to line of sight in kilometers per second.
			"	"	
0.7	α Centauri	43	3.62	0.72	23.9
6.8	21185 Lalande	64	4.75	.48	47.1
5.1	61 Cygni	70	5.17	.44	55.7
—1.4	Sirius	83	1.32	.37	17.
8.2	18609 Arg.-Œltzen.	88	2.30	.35	31.3
7.9	34 Groombridge	99	2.83	.31	43 5
7.5	9352 Lacaille	110	6.97	.28	118.5
0.5	Procyon	110	1.26	.27	22.2
9.	11677 Arg.-Œltzen	119	3.05	.26	55.7
6.5	1643 Fedorenko.	123	1.43	.25	27.2
8.5	21258 Lalande	128	4 40	.24	87.1
4.7	α Draconis	128	1.84	.24	36.5
3.6	σ Cassiopeiæ	147	1.19	.21	27.
0.2	η Aurigæ.	147	0.43	.21	9.8
9.	17415 Arg.-Œltzen	154	1.27	.20	30.2
0.9	α Aquilæ	154	0.64	.20	15.2
5 2	ε "Indien"	154	4.60	.20	109.5
4.5	o² Eridani	181	4.05	.17	113.2
2.4	β Cassiopeiæ	193	0.57	.16	16.9
1.	α Tauri	206	0.19	.15	0.
7.	1831 Fedorenko.	206	0.42	.15	13.3
4.1	p' Ophiuchi	206	1.13	.15	35.8
0.2	Vega	206	0.36	.15	11.4
2.2	α Urs. Min (Polaris)	440	0.05	.07	3.4

STARS WHICH HAVE LARGEST OF OBSERVED VELOCITIES IN THE LINE OF SIGHT.

Extract by the Astronomer Royal from an article in the Astrophysical Journal for January, 1901, by W. W. Campbell, director of Lick Observatory.

Magnitudes.		R.A.		Dec.		Velocity.
		h.	m.	°	'	kilometer per sec.
4.6	ε Andromedæ	0	33	+28	46	—84
	μ Cassiopeiæ	1	0	+54	20	—97
	δ Leporis	5	47	—20	54	+95
4.2	θ Canis Majoris	6	50	—11	55	+96
	ι Pegasi	21	17	+19	23	—76
4.1	μ Sagittarii	18	8	—21	1	—76

The + sign denotes recession, the — sign approach.

The velocity of the sun relatively to stars in general according to Kempf and Risteen is probably about 19 kilometers per second. In respect to greatest proper motions and velocities, Sir Norman Lockyer gives me the following information:

"The star with the greatest known proper motion (across the line of sight) is 243 Cordoba = 8.7 seconds per annum. Velocity in kilometers not known.

"1830 Groombridge has a proper motion of 7.0 seconds per annum and a parallax of 0.089 seconds, from which it results that the velocity across the line of sight is 370 kilometers per second. Various estimates of the parallax, however, have been made, and this velocity is somewhat uncertain. The star with the greatest known velocity in the line of sight is ζ Herculis, which travels at 70 kilometers per second.

"The dark line component of Nova Persei was approaching the earth with a velocity of over 1,100 kilometers per second."

This last-mentioned and greatest velocity is probably that of a torrent of gas due to comparatively small particles of melted and evaporating fragments shot out laterally from two great solid or liquid masses colliding with one another, which may be many times greater than the velocity of either before collision; just as we see in the trajectories of small fragments shot out nearly horizontally when a condemned mass of cast iron is broken up by a heavy mass of iron falling upon it from a height of perhaps 20 feet in engineering works.

Sec. 16.—Newcomb has given a most interesting speculation regarding the very great velocity of 1830 Groombridge, which he concludes as follows:

"If, then, the star in question belongs to our stellar system, the masses or extent of that system must be many times greater than telescopic observation and astronomical research indicate. We may place the dilemma in a concise form, as follows:

"Either the bodies which compose our universe are vastly more massive and numerous than telescopic examination seems to indicate, or 1830 Groombridge is a runaway star, flying on a boundless course through infinite space with such momentum that the attraction of all the bodies of the universe can never stop it.

"Which of these is the more probable alternative we cannot pretend to say. That the star can neither be stopped, nor bent far from its course until it has passed the extreme limit to which the telescope has ever penetrated, we may consider reasonably certain. To do this will require two or three millions of years. Whether it will then be acted on by attractive forces, of which science has no knowledge, and thus carried back to where it started, or whether it will continue straightforward forever, it is impossible to say.

"Much the same dilemma may be applied to the past history of this body. If the velocity of 200 miles or more per second with which it is moving exceeds any that could be produced by the attraction of all the other bodies in the universe, then it must have been flying forward through space from the beginning, and having come from an infinite distance, must be now passing through our system for the first and only time."

Sec. 17.—In all these views the chance of passing another star at some small distance such as one or two or three times the sun's radius has been overlooked; and that this chance is not excessively rare seems proved by the multitude of Novas (collisions and their sequels) known in astronomical history. Suppose, for example, 1830 Groombridge, moving at 370 kilometers per second, to chase a star of twenty times the sun's mass, moving nearly in the same direction with a velocity of 50 kilometers per second, and to overtake it and pass it as nearly as may be without collision. Its own direction would be nearly reversed and its velocity would be diminished by nearly 100 kilometers per second. By two or three such casualties the greater part of its kinetic energy might be given to much larger bodies previously moving with velocities of less than 100 kilometers per second. By supposing reversed the motions of this ideal history, we see that 1830 Groombridge may have had a velocity of less than 100 kilometers per second at some remote past time, and may have had its present great velocity produced by several cases of near approach to other bodies of much larger mass than its own, previously moving in directions nearly opposite to its own, and with velocities of less than 100 kilometers per second. Still it seems to me quite possible that Newcomb's brilliant suggestion may be true, and that 1830 Groombridge is a roving star which has entered our galaxy, and is destined to travel through it in the course of perhaps two or three million years and to pass into space never to return to us.

Sec. 18.—Many of our supposed 1,000,000,000 stars, perhaps a great majority of them, may be dark bodies; but let us suppose for a moment each of them to be bright, and of the same size and brightness as our sun; and on this supposition and on the further suppositions that they are uniformly scattered through a sphere (5) of radius $3.09 \,.\, 10^{16}$ kilometers, and that there are no stars outside this sphere, let us find what the total amount of starlight would be in comparison with sunlight. Let n be the number per unit of volume of an assemblage of globes of radius a scattered uniformly through a vast space. The number in a shell of radius q and thickness dq will be

MOTIONS OF STARS IN THE LINE OF SIGHT DETERMINED AT POTSDAM OBSERVATORY, 1889–1891.

[Communicated by Prof. Becker, University Observatory, Glasgow.]

Star.	Magnitude.	Velocity relative to the sun.
		Kilometer.
α Andromedæ	2.0	+ 4.5
β Cassiopeiæ	2.1	+ 5.2
α Cassiopeiæ	var.	—15.2
γ Cassiopeiæ	2.	— 3.5
β Andromedæ	2.3	+11.2
α Ursæ Minoris	2.	—25.9
γ Andromedæ	2.4	—12 9
α Arietis	2.	—14 7
β Persei	var.	— 1.5
α Persei	2.	—10.3
α Tauri	1.	+48.5
α Aurigæ	1.	+24.5
β Orionis	1.	+16.4
γ Orionis	2.	+ 9.2
β Tauri	2.	+ 8.
δ Orionis	2.5	+ .9
ε Orionis	2.	+26.5
ζ Orionis	2.	+14.8
α Orionis	var.	+17.2
β Aurigæ	2.	—28.1
γ Geminorum	2.3	—16 6
α Canis Majoris	1.	—15.6
α Geminorum	2.3	—29.7
α Canis Minoris	1.	— 9 2
β Geminorum	1.3	+ 1.1
α Leonis	1.3	— 9.1
γ Leonis	2.0	—38 5
β Ursæ Majoris	2.3	—29.3
α Ursæ Majoris	2.	—11 9
δ Leonis	2.3	—14 4
β Leonis	2.	—12.2
γ Ursæ Majoris	2.3	—26 6
ε Ursæ Majoris	2.	—30 3
α Virginis	1.	—14 8
ζ Ursæ Majoris	2.1	—31.2
η Ursæ Majoris	2.	—26.2
α Bootis	1.	— 7.7
ε Bootis	2.	—16 3
β Ursæ Minoris	2.	+14 2
β Libræ	2.	— 9 6
α Coronæ	2.	+32.
α Serpentis	2.3	+22.3
β Herculis	2.3	—3[illegible].3
α Ophiuchi	2.	+19.2
α Lyræ	1.	—15.3
α Aquilæ	1.3	—36 9
γ Cygni	2.4	— 6.4
α Cygni	1.6	— 8.
ε Pegasi	2.3	+ 8.
β Pegasi	var.	+ 6.7
α Pegasi	2.	+ 1.3

* "The potential energy of gravitation may be in reality the ultimate created antecedent of all the motion, heat, and light at present in the universe." See Mechanical Antecedents of Motion, Heat, and Light, Art. LXIX. of my Collected Mathematical and Physical Papers, Vol. II.

† To prove this, remark that the exhaustion of gravitational energy ($E = \frac{1}{8\pi} \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} R^2 dx\, dy\, dz$, Thomson and Tait's Natural Philosophy, Part II, section 549) when a vast number, N, of equal masses come from rest at infinite distances from one another to an equably spaced distribution through a sphere of radius r is easily found to be 3/10 Fr, where F denotes the resultant force of the attraction of all of them on a material point, of mass equal to the sum of their masses, placed at the spherical surface. Now, this exhaustion of gravitational energy is spent wholly in the generation of kinetic energy; and therefore we have

$$\Sigma \frac{1}{2} mv^2 = \frac{3}{10} Fr, \text{ and by (7) } F = 1.37 \,.\, 10^{-13} \Sigma m \text{; whence}$$

$$\frac{\Sigma mv^2}{\Sigma m} = \frac{3}{5}\, 1.37 \,.\, 10^{-13} . r$$

which, for the case of equal masses, gives, with (5) for the value of r,

$$\sqrt{\frac{\Sigma v^2}{N}} = \sqrt{(\tfrac{3}{5}\, 1.37 \,.\, 10^{-13} \,.\, 3.09 \,.\, 10^{16})} = 50.4 \text{ kms. per second.}$$

$n.4\pi q^2 dq$, and the sum of their apparent areas as seen from the center will be

$$\frac{\pi a^2}{q^2}\, n\,.\,4\pi q^2 dq \text{ or } n\,.\,4\pi^2 a^2 dq.$$

Hence, by integrating from $q = 0$ to $q = r$, we find

$$n\,.\,4\pi^2 a^2 r \text{ .... (8).}$$

for the sum of their apparent areas. Now if N be the total number in the sphere of radius r we have

$$n = N/\left(\frac{4\pi}{3} r^3\right) \text{ .... (9).}$$

Hence (8) becomes $N\,.\,3\pi\left(\frac{a}{r}\right)^2$; and if we denote by α the ratio of the sum of the apparent areas of all the globes to 4π we have

$$\alpha = \frac{3N}{4}\left(\frac{a}{r}\right)^2 \text{ ... . (10).}$$

$(1-\alpha)/\alpha$, very approximately equal to $1/\alpha$, is the ratio of the apparent area not occupied by stars to the sum of the apparent areas of all their disks. Hence alpha is the ratio of the apparent brightness of our starlit sky to the brightness of our sun's disk. Cases of two stars eclipsing one another wholly or partially would, with our supposed values of r and a, be so extremely rare that they would cause a merely negligible deduction from the total of (10), even if calculated according to pure geometrical optics. This negligible deduction would be almost wholly annulled by diffraction, which makes the total light from two stars, of which one is eclipsed by the other, very nearly the same as if the distant one were seen clear of the nearer.

Sec. 19.—According to our supposition of Section 18 we have $N = 10^9$, $a = 7.10^5$ kilometers, and therefore $r/a = 4.4.10^{10}$. Hence by (10)

$$\alpha = 3.87.10^{-13} \text{ .... (11).}$$

This exceedingly small ratio will help us to test an old and celebrated hypothesis that if we could see far enough into space the whole sky would be seen occupied with disks of stars, all of perhaps the same brightness as our own sun, and that the reason why the whole of the night sky and day sky is not as bright as the sun's disk is that light suffers absorption in traveling through space. Remark that if we vary r, keeping the density of the matter the same, N varies as the cube of r. Hence by (10) α varies simply as r; and therefore to make α even as great as 3.87/100, or, say, the sum of the apparent areas of disks 4 per cent of the whole sky, the radius must be $10^{11}.r$, or $3.09.10^{27}$ kilometers. Now, light travels at the rate of 300,000 kilometers per second, or $9.45.10^{12}$ kilometers per year. Hence it would take $3.27.10^{14}$, or about $3\frac{1}{4}.10^{14}$, years to travel from the outlying suns of our great sphere to the center. Now we have irrefragable dynamics proving that the whole life of our sun as a luminary is a very moderate number of million years, probably less than fifty million, possibly between fifty and one hundred. To be very liberal, let us give each of our stars a life of a hundred million years as a luminary. Thus the time taken by light to travel from the outlying stars of our sphere to the center would be about three and a quarter million times the life of a star. Hence if all the stars through our vast sphere commenced shining at the same time, three and a quarter million times the life of a star would pass before the commencement of light reaching the earth from the outlying stars, and at no one instant would light be reaching the earth from more than an excessively small porportion of all the stars. To make the whole sky aglow with the light of all the stars at the same time the commencements of the different stars must be timed earlier and earlier for the more and more distant ones, so that the time of the arrival of the light of every one of them at the earth may fall within the durations of the lights at the earth of all the others! Our supposition of uniform density of distribution is, of course, quite arbitrary, and (sections 13, 15, above) we ought in the greater sphere to assume the density much smaller than in the smaller sphere (5); and, in fact, it seems that there is no possibility of having enough of stars (bright or dark) to make a total of star-disk area more than 10^{-12} or 10^{-11} of the whole sky.

Sec. 20.—To understand the sparseness of our ideal distribution of 1,000,000,000 suns, divide the total volume of the supposed sphere of radius r (5) by 10^9, and we find $123.5.10^{39}$ cubic kilometers as the volume per sun. Taking the cube root of this, we find $4.98.10^{13}$ kilometers as the edge of the corresponding cube. Hence if the stars were arranged exactly in cubic order, with our sun at one of the eight corners belonging to eight neighboring cubes, his six nearest neighbors would be each at distance $4.98.10^{13}$ kilometers, which is the distance corresponding to parallax 0.62 second. Our sun, seen at so great a distance, would probably be seen as a star of something between the first and second magnitude. For a moment suppose each of our 1,000,000,000 suns, while of the same mass as our own sun, to have just such brightness as to make it a star of the first magnitude at distance corresponding to parallax 1.0 second. The brightness at distance r (5) corresponding to parallax 0.001 second would be one-millionth of this, and the most distant of our assumed stars would be visible through powerful telescopes as stars of the sixteenth magnitude. Newcomb (Popular Astronomy, 1882, p. 424) estimated between 30,000,000 and 50,000,000 as the number of stars visible in modern telescopes. Young (General Astronomy, p. 448) goes beyond this reckoning and estimates at 100,000,000 the total number of stars visible through the Lick telescope. This is only the tenth of our assumed number. It is nevertheless probable enough that there may be as many as 1,000,000,000 stars within the distance r (5), but many of them may be extinct and dark, and nine-tenths of them, though not all dark, may be not bright enough to be seen by us at their actual distances.

Sec. 21. I need scarcely repeat that our assumption of equable distribution is perfectly arbitrary. How far from being like the truth is illustrated by Herschel's view of the form of the universe as shown in Newcomb's Popular Astronomy, page 469. It is quite certain that the real visible stars within the distance r (5) from us are very much more crowded in some parts of the whole sphere than in others. It is also certain that instead of being all equally luminous, as we have taken them, they differ largely in this respect from one another. It is also certain that the masses of some are much greater than the masses of others, as will be seen from the following table, which has been compiled for me by Prof. Becker from André's "Traité d'Astronomie Stellaire," showing the sums of the masses of the components of some double stars, and the data from which these have been determined.

	Parallax.	One-half major axis— In seconds.	One-half major axis— In terms of semimajor axis of earth's orbit	Period in years	M + M' in units of the sun's mass.
	"				
α Centauri	0.75	18.17	25	84	2.0
61 Cygni	.44	29.48	68	783	0.5
Sirius	.89	8.31	24	52	3.2
Procyon	.27	5.84	4	40	6.3
o² Eridani	.19	5.72	28	176	0.9
η Cassiopeiæ	.15	8.20	39	190	4.8
ρ Ophiuchi	.15	4.60	30	88	3.6
Virginis	.05*	3.99	79†	194	15
γ Leonis	.02*	1.98	102†	407	6.5

* Parallax calculated from dynamical determinations of ratio of semimajor axis of double star's orbit to semimajor axis of earth's orbit.

† From spectroscopic observations by Belopolsky of Poulcowa, combined with elements of orbit.

Sec. 22.—There may also be a large amount of matter in many stars outside the sphere of 3.10^{16} kilometers radius, but however much matter there may be outside it, it seems to be made highly probable by Sections 11 to 21 that the total quantity of matter within it is greater than 100,000,000 times and less than 2,000,000,000 times the sun's mass.

I wish, in conclusion, to express my thanks to Sir Norman Lockyer, to the Astronomer Royal, Mr. Christie, to Sir Robert Ball, and to Prof. Becker for their kindness in taking much trouble to give me information in respect to astronomical data, which has proved most useful to me in Sections 11 to 21, above.

A CURIOUS FUNGUS FORMATION.

A PECULIAR FUNGUS GROWTH.

We present herewith a photograph, by Mr. C. H. Crosby, president of the Camera Club, of New York, of an interesting fungus growth. Mr. Crosby states that it grew upon the top of a solution of water and sulphuric acid stored in a stone jar, the solution being used to remove the gelatin films from spoiled and discarded negatives and plates, which were soaked in it from time to time.

The jar held five gallons of solution, and had a stone cover which had not been removed for a period of two months. One day on removing the cover, Mr. Crosby discovered this peculiar formation. The structure of the fungus was of a stiff fibrous nature, and the color ranged in places from light to dark green. After it had been floated from the top of the solution and dried, it contracted and split in several places.

Mr. Crosby is unable to account for this peculiar formation, and, although he has used similar solutions for the same purpose for a period of twelve years, he does not recall observing any such growth before.

A possible explanation may be due to the fact that emulsions of different compositions coated on the plates (which were cleaned off), combined with some chemical in the films and with the aid of heat, might have produced some sort of fermentation which developed into this peculiar growth.

TATTOOING AMONG SAVAGES.*

By RANDOLPH I. GEARE.

The antiquity of the practice of tattooing is unquestionable, although its certain origin will probably never be discovered. Herodotus speaks of it as used by the Thracians. Pointed bones, like those used by modern savages in tattooing, have been found in the prehistoric grottoes of Avignac and in the tombs of ancient Egypt. In this connection the Mosaic command, "Ye shall not make any cuttings in your flesh for the dead, nor print any marks upon you," becomes apparent. Lucian states that the Assyrians covered their entire bodies with figures, and Pliny says the same thing regarding the Dacians. The Phœnicians and the Jews, says Lombroso, traced lines, which they called "signs of God," on their foreheads and their hands. Among the ancient Britons the practice of tattooing was widespread, and their name ("Brith"= a painting) has been supposed to be derived from the custom. Cæsar, writing of these races, declares that they "trace, with iron, designs on the skin of the youngest children, and color their warriors with *Isatis tinctoria* [=woad] to render them more terrible on the field of battle."

Magitot, the ethnologist, classified the methods by localities, as follows:

1. *Tattooing by Pricking*, the needle being passed straight into the skin at different depths. This prevailed in Polynesia, except in New Zealand, in most of the Marquesas Islands, in Easter Island, and Micronesia, New Guinea, the Papuan groups and the Dayall group at Borneo. In South America it prevailed among the Charruas, certain tribes in Brazil, the Guaranis, the Pampeans, and the Patagonians. In North America, among the Indians. In Africa, among the Kabyles, the Arabs, the Egyptians, the Nyam-Nyams, the Senegambians, and the tribes on the banks of the Senegal. In Asia, among the Sengli of the island of Hainan, the ancient Koreans, the Baitos, and the Ouen-chin of Japan, the Koussilis, the Aleutians, the natives of Formosa, the ancient Annamites, and a savage people in the southwestern part of China.

2. *Tattooing by Simple Incision*.—This was practised in Melanesia, by African tribes at Loango, Makoundi, Mangandja, Machinja, on the east and south banks of Lake Tanganyika, in Guinea, and in New Zealand.

3. *Tattooing by Ulceration or Burning*.—This was the method employed by the Huns of Attila, in Tasmania, Australia, Guiana, by the New Guinea tribes of Papuans, the Mincopies, the Negritos, and the Alfouras; also in New Caledonia, in the Soudan, in Mozambique and in Zululand.

4. *Hypodermic Tattooing*.—This consisted in passing a needle charged with coloring matter, generally soot, between the epidermis and the true skin, in a slanting direction, and was practised by the Eskimos, the Tchouktchis, the Greenlanders, and to some extent in Italy.

5. *Mixed Tattooing*.—Throughout Europe the combination of Nos. 1 and 4 is employed. In New Zealand and among some African and Algerian tribes the processes by incision and by pricking are used. In the Marquesas Islands the methods of pricking and by ulceration are combined in some cases.

While this classification may not be of much popular interest, it is of value to the student; nor can it fail to produce in the mind of the general reader a feeling of surprise at the almost universal extent of the custom—now-a-days and in civilized countries—kept up chiefly by sailors and criminals either as an idle pastime, to commemorate certain events in their lives, or pertaining to their occupations, or else to emulate the adornments of their older comrades.

In Fiji tattooing is almost entirely confined to the women, but the larger part of the markings is covered by the fringe-apron or "liku." The young women usually tattoo their fingers with lines and stars, that they may appear ornamental in presenting food to the chief. When they become mothers, a blue patch is added at each corner of the mouth. A sharp-toothed instrument is used, like that employed in Samoa, in place of the chisel, as in New Zealand.

Among the Maoris, or natives of New Zealand, the women do not tattoo any part of their faces, excepting the lips, which thus become blue, for it is considered a disgrace for a woman to have red lips. This is done at the time when the girl is about to enter womanhood. The tattooing of the men presents a most formidable appearance. They have naturally a full beard, but every hair is removed from the face, in order that the tattooed patterns may not be concealed. The pigment used is made from the resin of the Kauri pine. The "moko" or tattooing of a New Zealander is really a mark of rank, and only slaves are forbidden the more or less complete tattooing of the face. A completely tattooed face is literally covered with spiral scrolls, circles, and curved lines; but though the principal marks are generally similar, they are not exactly alike on any two persons, owing to the almost infinite variety of combinations at the operator's command.

While a man is being tattooed, he receives the encouragement of his friends, and the friends of the operator also sing songs which, while intended to encourage the young hero, have rather a "Pullman porter" sound, in that they convey a strong hint that the beauty of the job will be in proportion to the amount of pay forthcoming.

Here is a translation of one of these songs:

"He who pays well, let him be beautifully ornamented:
But he who forgets the operator, let him be done carelessly.
Be the lines wide apart.
O hiki Tangaroa!
O hiki Tangaroa!
Strike that the chisel as it cuts along may sound.
O hiki Tangaroa!
Men do not know the skill of the operator in driving his sounding chisel along.
O hiki Tangaroa."

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT. This article should be read in connection with the illustrated article on the same subject, appearing in the current issue of the SCIENTIFIC AMERICAN.

A remarkable feature of the face tattooing in New Zealand lies in the fact that in early times it represented the warrior's name—it was his totem, and he signed official documents with an exact copy of the "moko," or tattoo.

In the Sandwich and Palliser Islands there is comparatively little tattooing done, though some of the natives have their arms and chests decorated with lines and figures, while the more common form consists of narrow circular or curved lines on different parts of the face. In Tahiti the bust, legs, arms, and hands of the men are tattooed, while the face is left generally unmarked. The women wear tattoo marks chiefly on the arms, ankles, and feet, the tattooing of the latter being continued on the legs nearly half way to the knees, so that at a little distance a woman appears to be wearing high boots or close-fitting stockings. Some of the figures employed are stars, circles, lozenges, etc., but the patterns are usually copied from some object in nature. Thus, a cocoanut tree is often represented, with its root spreading at the heel, the stalk extending along the tendon, and its waving plume spreading out gracefully on the broad part of the calf. Here, as in the other regions mentioned, tattooing has decreased very largely, owing to the discouraging attitude of the missionaries.

Leaving Polynesia, it is now in order briefly to refer to tattooing, or its equivalent, as practised among the Papuans or natives of New Guinea. Here the bodies of the natives are for the most part scarified, as among the Australians. Deep cuts are made into the flesh, and heat is then applied, resulting in swollen projections rising as much as half an inch above the surface. In New Caledonia there seems to be little tattooing, but in its place black lines running diagonally are drawn across the breast with charcoal. In the tribes bordering on Redscar Bay, the men are tattooed on the breast, cheeks, forehead, and arms, while the women are so covered with blue spots that there is hardly a part of their bodies left unmarked. They use various patterns, the usual one consisting of double parallel lines, the intervals between being filled with smaller patterns or zigzag lines. In the northwest part of New Guinea the "Dory" men scarify their bodies, and also tattoo their breasts and arms with figures of their weapons. In the Marshall Islands the tattoo is used in profusion, both sexes being equally addicted to it. Wood, in his "Illustrated Natural History," gives a striking illustration of two young women of the Caroline Archipelago, with tattooed arms and bodies. In the Pelew Islands, where clothing is entirely discarded, the absence of it is made up for by completely tattooing the body. Dr. Alfred C. Haddon, in his book on "Headhunters," states that the eastern Papuans are all tattooed, but while the younger men appear to tattoo only the face, some of the old men have patterns on the arms, legs, and chests. The women also are tattooed more or less all over. Their skin is so dark, however, that the tattooing is not very clearly seen.

Some of the western Papuans ornament their body by means of severe scars. This practice of scarification has ceased in Torres Straits and is diminishing on the mainland of New Guinea, but Dr. Haddon saw many men among the Torres Straits islanders and western Papuans who were tattooed in imitation of the Polynesians or eastern Papuans. On Haidana Island, Dr. Haddon found the women very richly tattooed, but the men only to a small extent, usually limited with them to a few broken lines on the face.

At Babaka, on the Hood Peninsula, Dr. Haddon persuaded one of the girls to allow herself to be tattooed, so that he might watch the operation. He writes: "The girl lay on the ground, and the operator held a special clay vessel in one hand, in which was a black fluid paste made from burnt resin; this was applied on the skin by means of a little stick. When the design was finished, a thorn was held in the left hand, while in the right hand was a small stick round which strips of banana leaves were wound. The thorn was lightly tapped with the stick until the pattern had been well punctured into the skin."

On Yule Island, according to the same observer, the women tattoo from head to foot, although among neighboring tribes the tattooing is less complete.

Another writer states that the women of the Mekeo District are not acquainted with tattooing, but probably his observations related only to villages far inland, for at Veifaa Dr. Haddon sketched two women whose torsos were richly tattooed. He also states that each tribe has its distinctive pattern, and that "any infringement of copyright would be a valid reason for war."

In Australia and in many parts of Africa the practice of scarifying the body or tattooing by cuts, but without the addition of coloring matter, is still in vogue. The scars usually run longitudinally (or alternately longitudinally and transversely) down the upper arm, while occasionally they appear also on the breast, somewhat in the shape of a fan, spreading from the center of the body to the arms. One Australian chief was observed to be entirely covered from his neck to his knees with scars an inch broad, set closely together and covering the whole of his body.

The scars as a rule signify in part at least the district to which the person belongs. This system of gashing extends to the youths, nor are they fully recognized as men until they have endured it. In this curious rite they are first forced to swallow blood fresh from the veins in their sponsors' arms; they are then placed on their hands and knees, more blood running over their backs so as to form a coagulated mass, in which the pattern for tattooing is traced. A deep incision is then made in the nape of the neck, and broad gashes are cut from the shoulder to the hip on each side, almost an inch apart. These are pulled open (imagine the agony!) as widely as possible, while the men repeat in a low voice the following incantation:

> "Kanya, Marra, Marra
> Kauo, Marra, Marra
> Pilbirri, Marra, Marra."

What this means I have not been able to discover. The ceremony is concluded by the men clustering around the initiated youths, giving them detailed advice as to hunting, fighting, and concealing pain.

Tattooing by cuts leaving raised cicatrices prevails more or less all over Africa. On the west coast three cuts on each side of the cheek, in red and blue, seem to be the principal decoration. Dr. Holub, speaking of the Koranna tribe, says: "They have among themselves a kind of free-masonry. When questioned, they confessed that they belonged to something like a secret society. One of them said, 'I can go all through the valleys inhabited by Kavannas and Griquas, and wherever I go, when I open my coat and show these three cuts, I am sure to be well received.'" Along the equator the tribes cover the entire body with scars of raised lumps produced by slitting the skin and rubbing some irritant into the incision, and this mode of ornamentation is in vogue along the Congo up to the Stanley Falls. The marks are all tribal. Thus, the Bateke are distinguished by five or six striated lines across the cheek-bone, while the Bayansi scar their foreheads with a horizontal or vertical band.

The natives of Mashonaland tattoo women's breasts on their chests.

Several of the tribes of Borneo practice tattooing, the men sometimes being nearly covered, while others have stars on their breasts, and armlets and bracelets on their legs and arms. The men of the Malanan tribe of Dyaks are tattooed from the breast to the knees with a sort of scale-armor pattern, while many tattoo their chins and chests, which causes them to appear to have real beards and mustaches.

The Kayan men have devices tattooed on the forearm and thigh, and frequently there is a rosette or circular design on the shoulder. The back of the hand and fingers are tattooed when the man has "taken a head." The Kayan women are tattooed all over the forearm and over the back of the hand. The thighs are also richly tattooed, as well as the upper surface of the feet and toes. They follow in general the plan of the Samoan warriors.

The Iban women (sea Dyaks) do not care much for tattooing, but most of the men have adopted the practice from the Kayans, and admit that the marks are Kayan designs. The Ibans probably belong to the same stock as the original Malay, and if this is so, the Iban migration may be regarded as the first wave of the movement that culminated in the Malay Empire. A very repulsive example of tattooing was observed in the Burmese Empire, where a young noble's body was encircled with thirteen fabulous birds in vermilion, each one standing on a monkey's head. The monkeys, which were done in blue, grinned on the backs of thirteen blue hogs.

The natives of the Andaman Islands, Admiralty Islands, and Solomon Islands tattoo by means of gashing, first by way of ornament, and secondly to prove their power of enduring pain. Women are generally the operators, and they now use a piece of glass, but formerly a flake of quartz was employed. The marks here, as in Africa, are tribal, and consist of lines down the back and in front. The face is never tattooed in the Andaman Islands, but in the Admiralty Islands all the women are tattooed with rings around the eyes and over the face and in diagonal lines over the upper part of the front of the body.

In South America tattooing is quite uncommon. Perhaps the Mundurucú tribe of Amazonians tattoo as elaborately as any, although not with much distinction of finish. They seem to have no idea of a curved or scroll-like pattern, and content themselves with straight lines. One of their favorite plans is to cover the whole body with a trellis-like pattern, the lines crossing diagonally or at right angles. One man, observed by a traveler, had a large black patch on the center of his face, covering the lower part of the nose and mouth, while his body was decorated with a blue checkered pattern, and his arms and legs with stripes.

On Easter Island tattooing does not seem to be practised at the present time, although persons advanced in life are found ornamented on all parts of the body. Both sexes were tattooed in former years, the women to a greater extent and much more elaborately than the men. The specimens of tattooing on a native woman of Easter Island here shown were reported by William J. Thomson, U. S. N., and were reproduced in his paper on Easter Island published in the Report of the National Museum for 1889. In addition to the ornamentation of the body, there was in certain instances a narrow band around the upper part of the forehead, with little circles extending down upon the forehead and joined to the band by a stem. The lips were freely tattooed, as with the Maoris, with lines curving around the chin and extending toward the cheek-bones, while the entire neck and throat were covered with oblique or wavy lines, with occasional particles of solid coloring. The Easter Island style differed from that of Samoa and other localities in that the designs in the former were only limited by the fancy and ability of the artist, whereas in the latter, a standard pattern was adhered to. The material used in Easter Island for tattooing was obtained by burning the leaf of the plant called "ti," which was moistened with the juice of the "poporo" berry. The tattoo "comb" was made of bones fastened to a stick.

Among the North American Indians the women are fond of tattooing themselves, producing blue and red patterns by having charcoal and vermilion rubbed into the punctures. The tattoo marking here shown was observed on a Haidah chief. It represents "Oolala," a mythological being in whom the Indians of Queen Charlotte's Island have great faith. Half a man and half a bird, this "Skookum" or evil spirit is supposed to inhabit the mountains and to live on either whales or Indians.

The Serrano Indians of Southern California formerly practised tattooing, the designs upon the cheeks or chin being also drawn or incised upon trees or posts which marked the boundaries of the individual pos-

SPECIMEN OF MAORI TATTOOING.

DAUGHTER OF CHIEF, SHOWING FEMALE TATTOOING.

sessions. In the northern part of California only the women tattoo, and the custom is said to have originated there from the necessity of having some means of identifying captives taken during war. Hence the lines are in reality marks of tribal distinction.

The Klamath Indians of Oregon had a single line of black running down over the middle of the chin. The women had three lines, one from each corner of the mouth, and one from the center of the lower lip, reaching down to the end of the chin. Half-breed girls had only one line in the middle of the chin. The material used was generally some root or finely powdered charcoal, and the pricking was produced with a sharply-pointed piece of bone, thorns, fish-spines, or (more recently) needles.

The Eskimo women tattoo themselves and in some places cover their limbs and other parts with various patterns. Others tattoo the forehead, cheeks and chin, generally indicating thereby that they are married. The name "Kakeen" is their equivalent for tattoo. The following account of the operation is related by Captain Lyons, who submitted to it from a desire to see what it was like.

"Having furnished herself with a fine needle, she tore with her teeth a thread off a deer's sinew, and thus prepared the sewing apparatus. She then passed her fingers under the bottom of the stove pot, from whence she collected a quantity of soot. With this, together with a little oil and much saliva, she soon made a good mixture, and taking a small piece of whalebone, she then drew a variety of figures about my arm. I had, however, only determined on a few strokes, so that her trouble was in some measure thrown away. She commenced her work by blackening the thread with soot, and taking a pretty deep but short stitch in my skin, carefully pressing her thumb on the wound as the thread passed through it, and beginning each stitch at the place where the last had ceased. When she had completed about forty stitches, I thought fit to allow her to desist; then rubbing the part with oil, in order to stanch the little blood which appeared, she finished the operation. The color which the 'Kakeen' assumes when the skin heals, is of the same light blue as we see on the marked arms of seamen."

RADIUM IN THERAPEUTICS.

The energy produced by the radio-activity of radium particularly is of so intense a character that even with the minute quantities of it which physicians are able to obtain some very interesting results have been secured. Cable reports show that in Vienna radium has been used with excellent effect on a number of patients suffering from the most intractable forms of malignant disease.

Patients have been presented before both the prominent medical societies of Vienna, the Society of Physicians, and the Imperial Academy of Sciences, in whom cancer has been cured, at least for the time being, by exposure to the rays of radium.

The effect of radium upon the external layer of cells is such that after an exposure of a few hours a slough ensues and the resulting ulcer is so difficult to heal that it is very evident that the trophic nerves to the part have been interfered with. As a malignant neoplasm is after all an exhibition of hypertrophy of tissue under the influence of some irritant, be it a parasite or something else, or is due to a disturbance of the normal vital relations of cells to one another with the consequent production of a cell insurrection, as it were, it is evident that the disturbance of the trophism of the part may well prove the secret of the natural cancer cure. This is probably the way in which the mixed toxins act, when they produce their wonderful curative effect.

The first patient presented to the medical societies of Vienna was a man of sixty-one, who had suffered for many years from cancer of the lips, which in spite of numerous operations had not been eradicated, but had eventually invaded the palate. This invasion had become so extensive that during the early months of the scholastic year 1902 the surgeons had pronounced further surgical treatment as likely to prove fruitless. Under these circumstances the use of radium was suggested and a very minute portion of the bromide salt of radium was obtained. This is the purest form of the material as yet available, and it is said that only a very minute portion, a few milligrammes, scarcely more than a tenth of a grain, were employed. The malignant condition gradually healed and for some time has ceased to give any manifestation of activity.

At the last meeting of the Imperial Academy of Sciences of Vienna, to which this patient was presented, further reports of the use of radium in the treatment of malignant disease were made. In one case a cure seems to have been effected in that most obstinate of all forms of malignant neoplasm, a melanosarcoma. Of course it can be readily understood that such reports are only preliminary. Until at least three years have passed there must remain a question in the mind of serious physicians of any radical cure of cancer. The relief afforded by radium, however, seems to be exactly of the kind which is produced by the X-rays, only the radio-active metal has the advantage of producing more intense and rapid effects and seems also to be more generally applicable than the X-rays have proved to be.—Medical News.

The Austrian and German governments have arrived at an understanding with reference to a plan purporting to establish a connection between the waterways of the Elbe and those of Dniester, whereby a direct waterway between the Black Sea and the North Sea and the Baltic will be created. This is to be brought about by means of the rivers Elbe, Oder, Weichsel, its auxiliary the Sau, and Dniester. The new waterway will be the shortest connection of the kind between the Black Sea and the northwestern part of Europe, and will much benefit the towns of Odessa, Warsaw, Hamburg, Lübeck, and Stettin, and also Vienna. The two powers are now in negotiations with Russia, which country is, of course, much interested in the realization of the plan.

ENGINEERING NOTES.

According to a report of the general management of Roumanian railroads, 342 locomotives out of a total of 482 are designed to be fired either with residue of petroleum or with brown coal; 17 locomotives use residue of petroleum exclusively. The Monitor of Roumanian Petroleum Interests states that the Society of Petroleum Explorers and Producers has now requested the management of the Roumanian railways to change all the locomotives into burners of petroleum residue and to introduce this fuel into the railroad shops.

The gage of the National Railroad of Mexico has been changed from San Luis Potosi to Gonzalez, a distance of 130 miles. This completes the change of all that part of the main line to standard gage, and there only remain to be completed about 70 miles of the new line between Huehuetoca and Gonzalez. It is expected that this will be finished by September. This new line, when completed, will shorten the distance between Laredo and the City of Mexico by 38 miles. The change of gage was begun about January 1, 1902, and since that time 800 miles of line have been altered.

The water power of the Chicago Drainage Canal is to be developed, after some years of investigation and delay, by the Sanitary District. At Lockport, the canal will be extended south about two miles, and near the present controlling works there will be a power house, with turbines utilizing the power from a fall of 34 feet. The tail race will be about 1½ miles long, extending to the lower basin at Joliet. There will be seven electrical generators of 5,000 horse power each, driven by three pairs of turbines on a horizontal shaft. A lock will be built to provide for navigation. The cost of the work is estimated at $2,750,000, and it is expected that it can be completed in two years. Mr. Isham Randolph, of Chicago, is chief engineer, and bids for the work will be received until October 7.—Engineering News.

Tensile tests of timber may be made on simple prismatic pieces, instead of on pieces with enlarged ends, according to the experience of Mr. E. Palacio, of Buenos Aires, Argentina. In a large series of timber tests carried on at the University of Buenos Aires, the test-pieces for the tensile tests were simple rectangular strips, 5 x 2 x 50 centimeters (about 2 x ¾ x 20 inches, and the ends were held between the jaws of the testing machine by means of wooden wedges. The wedges had a bearing on the test-piece for a length of 12 centimeters (4¾ inches), thus leaving a free length of 10 inches at the middle of the test-piece. All the specimens tested broke in this free length and not under the wedges as might be anticipated. A summary of the tests, which covered over a score of different woods, will be found in La Ingenieria, of Buenos Aires, issue of May 31, *et seq.*—Engineering News.

The Hudson River tunnel, says Engineering Record, has long held a unique place in American engineering. When it was first started, few believed in it. The method of carrying on the work was changed several times. The pilot-tube system of tunneling was invented by Captain Anderson for use in this work, and proved very serviceable. Finally, a terrible accident, in which many men were drowned like rats in a cage, brought the work to a standstill. Later it was undertaken with a shield instead of a pilot tube, and was pushed forward with fair success until funds gave out. Finally it has been taken in hand by electric railway interests for whom Mr. Charles M. Jacobs is chief engineer. In its present condition it is probably the most remarkable subaqueous tunnel ever driven. Not only is the depth of water great and the earth cover over the tunnel very thin in places, but the shield must be advanced through material partly silt and partly rock. To do this Mr. Jacobs employs a special form of shield with a horizontal apron projecting in front. Under the protection of this apron the miners build a timbered gallery or drift in which they drill and blast out the rock without trouble as explained elsewhere in this issue. The details of this work have never been published before, and will probably prove one of the most important improvements made in shield tunneling since the system was introduced.

Probably the greatest impetus has been given to the large gas engine by blast furnace gas utilization. It was only in 1896 that the writer made the first public and independent test of the first gas engine ever worked with blast furnace gas. Since that time the use of such gas in gas engines has become comparatively common. More has been done upon the Continent of Europe than in Great Britain, but much more would have been done had not the Continental engineers got hold of the curious and erroneous idea that blast furnace gas could be used in the gas engine with all its load of grit and dust without cleansing. Though progress has been slower in Great Britain, no British engineer has proposed such a folly as this, and the British cleansing method of Thwaite, the originator of the whole system, has now received universal recognition as an essential part of the utilization of this gas.

If the gas furnace were used to its full capacity it would provide power in immense quantities and this could be electrically transmitted by high-tension lines to centers of large industry or population. Transmission can be effected only electrically; hence the demand which is growing up for large gas engines that will run steadily enough to drive alternating-current machines.

While the blast furnace has done, and will do, so much for the large gas engine, it may be pointed out that gas power plants have probably failed in the past because of the difficulty with premature explosions, due to gas too rich in hydrogen. Blast furnace gas has been called miserable stuff, because it will hardly burn at atmospheric pressure in the cold vicinity of steam boiler plates, and Mr. Tom Westgarth states that when burned under boilers it will not produce more than one-fourth the power that it will give when used in gas engines. More favorable estimates give the ratio at even a sixth. In any case, the difference is so great that the gas engine must inevitably be the future user of blast furnace gas.—Cassier's Magazine.

ELECTRICAL NOTES.

Whenever electricity is used in connection with cyaniding there is a larger expenditure of chemicals and the base metals are dissolved to a much greater extent along with the gold and silver. However, when electric current is employed, a weaker cyanide solution may be employed, as its action is increased by the current.

Mr. Vivyan, the engineer in charge of the Marconi wireless telegraph station at Table Head, says that he is sending messages of different lengths to Cornwall daily, but that the replies are still being sent by cable because the installation of the new apparatus in the English station has not as yet been completed.

A German physicist, Dr. Blockmann, of Kiel, has made some experiments with lenses of resin, paraffin, glass, and other materials of high dielectric constants with a view of controlling Hertzian wave propagations to definite directions. He claims to have succeeded fairly well at moderate distances, and, if this is so, there is more chance of wireless telegraphy being of real service at sea during a fog. With such an apparatus a ship could ascertain by wireless telegraphy the direction in which the signaling station lies, which is not the case at present.

It is said that the United States war vessels "Prairie" and "Topeka" are being fitted with the Slaby-Arco system of wireless telegraphy. Experiments conducted by the Bureau of Equipment for more than a year, to determine the best system of wireless telegraphy for use on warships, have ended with this result. Twenty sets of Slaby-Arco instruments have arrived in New York from Germany. They are being distributed among eight warships, by which they will be used in the coming joint war games and field maneuvers. The vessels designated for this practical work are the battleships "Kearsarge," "Illinois," "Maine," and "Texas," and cruisers "Olympia" and "Baltimore," and the training ships "Topeka" and "Prairie."

In the early experiments with nickel plating great difficulties were experienced on account of the tendency of layers of electro-deposited nickel to peel off. This difficulty has now been more or less successfully overcome and various secret "dopes" are used by practical platers to get a firm deposit. A patent has been granted on July 28 to Mr. Thomas A. Edison for the following method by which a thin electrolytic deposit of nickel on iron or steel can be rendered firmly adherent. After completed electrolysis the nickel-plated pieces of iron or steel are brought into a non-oxidizing atmosphere for instance of hydrogen and heated to a temperature sufficient to weld the film of nickel to the iron or steel backing. A bright yellow heat is required for that purpose. The contact thus produced between the nickel and iron or steel is so perfect that sheets plated in this way can be formed into various articles by the drawing or stamping process without cracking or flaking the film.

A very ingenious electrical typesetting machine is briefly described by M. Tavernier in a recent issue of the Comptes Rendus of the Paris Academy of Sciences. The apparatus is similar in principle to the familiar linotype machines, but the operations of typing the copy and casting the type are separated; the operator works at an electrical typewriter, which produces a perforated tape, and at the same time an ordinary typed copy of the manuscript, which enables corrections to be made in the tape before the type is set up. The perforated tape is passed automatically through the typesetting machine, which is also operated electrically. The advantage of thus dividing the two operations is that the casting machine can be worked at a uniform maximum speed, and is independent of the skill of the typist. A further modification of the machine allows it to be used telegraphically; the perforated tape produced by the typewriter is passed through a transmitter, which sends signals over the line and reproduces in a receiving apparatus a duplicate of the tape, which can be used in the typesetting machine. The details of the various pieces of apparatus are not given, but there can be no doubt that the invention is likely to prove of great utility.

Mr. A. Pollak has sent us a pamphlet describing the development of the Pollak-Virag high-speed telegraph. Since its exhibition at the International Conference at Paris, in 1900, the apparatus has been improved and is now in successful use between Berlin and Frankfort, a distance of about 370 miles. The chief difficulties were the construction of automatic developing apparatus and a perforating machine, both of which raised entirely new problems. The former apparatus, now perfected, enables development to be completed in from 5 to 6 seconds, and fixing in 6 to 7 seconds, while the sensitive paper leaves the apparatus almost dry and ready for delivery. The perforator is operated like a typewriting machine, needing a minimum of practice, and is capable of perforating five or six letters per second. The system was applied with the improved apparatus over the line between Pozsony and Buda-Pesth, 133 miles long, and worked satisfactorily from October 24 to December 18, 1902, reaching when required a speed of 45,000 words per hour with two line wires. On the strength of this performance the Hungarian Academy of Sciences awarded the inventors the Wahrmann prize; the Hungarian postal department also reported most favorably on the practical working of the system, but could not adopt it because the telegraph department could not find enough work for it! Later, Herr Pollak (unfortunately Herr Virag died in 1901, at an early age of thirty-one) demonstrated the apparatus at Berlin before the German emperor, and experiments were carried out by the Imperial post and telegraph department on lines between Berlin and Königsberg, 370 and 440 miles in length, with satisfactory results, in consequence of which the system is now in practical use between Berlin and Frankfort by the Imperial post office.

It may be noted that iron wire lines are not suitable for use on the Pollak-Virag system, owing to electromagnetic inertia difficulties, but bronze lines are perfectly satisfactory. The telegrams are reproduced by the apparatus, not on ribbons, but in column form on paper 2¾ inches wide, ready for delivery without rewriting or pasting on a form.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American Cement Machinery in Spain.—During the past year there has been under course of construction near Pobla de Lillet, province of Barcelona, a plant for the production of Portland cement which, it is claimed by the company undertaking the enterprise, will be equal in grade and quality to that produced in any country in the world.

It was expected that cement from this mill would be ready for shipment some months ago, but the difficulty in transporting the heavy machinery for the kilns over a mountainous country to the cement beds has caused delay, owing to the necessity for building many temporary bridges and roads. I am informed that cement will be produced in six months.

Besides showing the opportunities afforded by this country for the investment of capital, this enterprise—one of the largest in Spain built with Spanish money—is interesting to Americans, inasmuch as it has been equipped entirely with American machinery costing over $250,000 and handled by American engineers, a proof of the confidence existing in this country in the ability of our machinery manufacturers and engineers.

I am indebted for the following description of this cement factory to Mr. W. W. Ewing, its chief engineer:

"The cement plant of the Compañia General de Asfaltos y Portland at Pobla de Lillet, province of Barcelona, is installed at present with three modern rotary kilns and all the necessary rock-reduction and clinker-refining machinery as used in modern practice in Pennsylvania, the various machines and kilns being placed on different levels, all forming what is generally known as a gravity plant.

"The rock enters the mill at an elevation of 161 feet above the lowest level, or level of the road, and gradually passes from the rock breaker to the stone rolls and then to the stone drier, from which it is conducted to the ball and tube mills, when it is ready to be fed into the upper ends of the rotary kilns. At the same time this process is in progress, in a separate building the soft coal is being dried and pulverized and conducted to tanks in front of the rotary kilns, to the lower, or front, end of which a center feed of pulverized coal is governed and effected by an air blast. The feed of pulverized stone and coal are so regulated as to furnish the necessary quantity of both kinds of raw material—also to effect the required degree of temperature—to produce in a calcined form normal Portland clinker, which by special cooling devices is made ready for the finishing ball and tube mills, from which latter machines the finished cement is conveyed to the stock house and finally to the packing and shipping rooms, where it is loaded onto wagons of large capacity, ready for hauling by a 50-horse power steam locomobile, made in California, to the nearest railway station.

"The plant is to be driven by vertical impulse water wheels of the latest improvement, each wheel being designed with the special speed to suit the machine or machines to be driven. There are nine separate wheels or drives which afford the supreme advantage of running any one or all parts of the machinery in the various departments at will.

"The power to drive the mill is furnished by a waterfall conducted to the mill by a metal pipe line 4.7 kilometers (2.9 miles) in length, furnishing normally about 2,400 horse power.

"The pipe line traverses a rugged, rocky cañon from the mill to the source of the Llobregat River, there being necessary along its length five trestle bridges, one tunnel 100 feet long driven through solid rock, many large rock cuts, and masonry piers of support for pipe. In order to lay this pipe, special roads and incline planes have had to be built to reach, first, the mill with the pipe, and finally its disposition along the line, the latter being by far the more difficult.

"The coal for the manufacture of the cement it is proposed to extract from a special lignite mine, from which an aerial cable will conduct the material to either a deposit next the company road in Pobla de Lillet or to the mill direct.

"In the mill there is to be installed a special compressed air and electric light plant for operating the rock drills and lighting the mill and the engineer's house, as well as the administration and chemical-laboratory buildings. There will also be installed a complete machine shop for making repairs of all kinds, which in a cement mill of this kind is an imperative necessity.

"The capital invested is some 2,500,000 pesetas ($482,500). The quality of cement is to be equal to the highest grade of the Portland cement made in the Lehigh district of Pennsylvania, the raw product being identical. The present building, one-half of the original project, is 116 by 395 feet by an average height of about 30 feet on each level, of which there are 14. The properties, including the asphalt, cement rock, coal, and forest claims, are very extensive, there being enough cement rock to last for centuries.

"The estimated daily output will be 500 barrels (100 tons) with the present installation. In the near future it is proposed to increase the output to 1,000 barrels per day, there being sufficient power in reserve to operate the larger mill.

"With the mechanical advantages possessed in having the latest improved American cement-making machinery and water-wheel construction, combined with the natural advantages of water, rock, and coal, it is assured that the cost of production will be such as to guarantee a greater consumption of Portland cement in Spain, and therefore lead to the more extensive developments of this steadily rising industry within the Iberian Peninsula."—Julius G. Lay, Consul-General at Barcelona.

Insecurity of the Harbor of Valparaiso.—The statistics on shipping in the harbor of Valparaiso for the past year note the arrival of 8,000 vessels of all classes and the departure of practically the same number, with a tonnage, both incoming and outgoing, of something like 12,000,000 tons.

Notwithstanding the great shipping interests represented by these figures and the further fact that Valparaiso is the chief commercial port of Chile—the second city in size in the republic, with a population of 150,000 inhabitants—the harbor, or rather the bay upon which the city is built, is one of the most insecure on the west coast of South America. There is absolutely no protection to ships and shipping interests against the strong winds and severe storms that prevail during the months of June, July, and August of each year. There is no breakwater in the Bay of Valparaiso, which fronts to the north, the direction from which the severe storms and heavy seas come during the winter months. As a result, great damage is done to vessels in port and to cargoes along the water front by the storms called "northers." Not infrequently ships and many lives are lost. The insecurity of the harbor is such that most of the steamships put to sea upon the approach of a norther in order to avoid possible disaster. Sailing vessels, of which there are always a large number in port, are unable to quit the harbor in time of storms; consequently, many are damaged or are driven ashore and destroyed.

A disastrous storm visited this port Monday, June 2, destroying a fine passenger steamer, the "Arequepa," of 3,000 tons register, of the Pacific Steam Navigation Company, with about one hundred persons on board, including passengers and crew. Of this number only about twenty were saved.

During the same storm two sailing vessels were driven onto the "malecon" and destroyed. They were the British bark "Foyledale" and the Chilian bark "Chivilingo." The wife and daughter of the captain of the "Foyledale" were lost. The German ship "Persimmon" was also driven from her moorings and drifted into one of the floating docks in the harbor, causing considerable damage.

The mole along the water front was almost entirely destroyed and a great deal of valuable cargo awaiting transfer from the shore to ships in the bay was destroyed. In addition to the disasters and damages above enumerated, there was also great damage to small craft in the bay.

Statistics show that every season heavy damages are sustained in the Bay of Valparaiso from the storms that prevail in this latitude during the winter months, and that on an average of once in seven years some terrible disaster, like that of June 2, occurs, resulting in the destruction of vessels and great loss of life.

The natural conditions of the Bay of Valparaiso make the building of breakwaters impractical because of the deep water at the mouth of the harbor and the heavy seas that are driven in by the north winds. These conditions and the damages resulting therefrom annually have a tendency to divert from this port much of the shipping trade that formerly came to Valparaiso.—R. E. Mansfield, Consul at Valparaiso.

Meat-Inspection Law of Prussia.—In order to do away with difficulties and misunderstandings which became apparent when the law for the import and inspection of foreign meat began to take effect, the Prussian Ministers for Agriculture, Finances, and Trade and Industry, with the sanction of the Chancellor, have issued the following instructions:

1. Fresh animal blood must be counted as meat, and can therefore be imported only in "whole bodies of animals." Salted blood is excluded because the necessary certainty of harmlessness to human health cannot be arrived at in blood which is not contained in bulk. Heavy salting of blood of sick animals gives no guaranty against danger to human health. Also all other parts of warm-blooded animals, as long as they are intended for food for human beings, are allowed to be imported in fresh condition only when these parts are in natural coherence to the whole animal body or its halves. This includes particularly such inner organs the importation of which does not naturally follow the import of other parts; for instance, fresh lard or fresh intestines which are not contained in the animal body are forbidden to be imported, even if they reach the place of inspection together with the bodies of which they were presumed to have been a part before.

2. The admission of well-boiled liver, which up to date was permitted to enter, is declared to be contrary to the law of inspection of meats. Prepared meat is admissible only if in its origin and preparation there is, according to experience, no danger to human health, or if its harmlessness to health can be proved positively at its importation. Neither the one nor the other of these conditions exists with cooked livers, for if the cooking of livers is not sufficient to kill all animal or botanical germs, unsound adhesions to the liver cannot be removed at all by cooking; therefore, unsound livers, even after the most thorough cooking, still retain the condition of rotten and disgusting nutriments. Besides all this, the cooking of the liver, more than any other system of preparing the same, is calculated to cover up the unhealthy condition of this organ; fresh tuberculous formation, young cysts, etc., are liable to be so changed by the process of cooking that they are not very easily detected on examination.

3. Since the inner organs of animals, particularly of pigs, singly, seldom reach the weight of 4 kilogrammes (8.8 pounds), there has been developed in several places of inspection the import of such organs adhering to different parts of the animal body in a pickled condition. As long as these coherent parts really weigh at least 4 kilogrammes, and as long as it can be proved that a rigid examination shows that these inner parts have absolutely lost the condition of fresh meat, there is no objection to the importation of such parts, provided that the final inspection permits a favorable report.

4. The ordering of lard prepared in foreign countries very often is done after the receipt of samples; therefore it happens often that samples of this lard are imported in small lots and of unimportant weights. It is ordered that the chemical inspection of parcels up to 1 kilogramme (2.2 pounds) can ordinarily be dispensed with, and it is considered necessary only when on first examination the condition of the sample causes suspicion.

5. Meat peptones as such are allowed to be imported, but since meat powder and meat flour are named among such products of meats, as sausages, etc., which, on account of consisting of hashed meat, are excluded from import, there exist doubts as to meat peptones having the privilege of being imported. Until further orders, peptones necessary for medical purposes, even if they quite resemble meat powder, are not to be considered as meat in the sense of the law for inspection of meats and can be imported without examination.

6. It has been found that some imported meats contain borax, of which, according to appearances, it would seem no use has been made with the intention of preserving the meat. For instance, the meat could have become affected by the borax contained in packing material which had been used previously to carry goods containing borax; but since the importation of all meat containing borax is strictly forbidden, meat thus affected must be excluded.—W. Bardel, Consul at Bamberg.

Demand for Codfish in Spain.—According to the Board of Trade Journal, published at London, the British consul at Malaga reports that the demand for codfish this season has been active, helped by moderate prices; but the importation of the article has fallen off considerably, compared with past seasons. The Newfoundland shippers appear to be paying less attention to shipments. The British vice-consul at Carthagena strongly recommends shippers to be careful in selection of fish sent to Carthagena, so as to avoid grounds for claims being made which are not infrequently disproportionate to faults committed in shipment.

American Typewriting and Salt-Mining Machines Wanted.—Under date of June 15, 1903, Consul C. R. Slocum, of Warsaw, reports that inquiries have been made at his office for typwriting machines of the description known as "visible writing" and for salt-mining machinery for evaporating processes. Two of the best-known makes of typewriters—one of them of the "visible" class—are represented at Warsaw by agents, but the demand seems to be for those which retail at a lower figure. It is particularly desired that prices be quoted c. i. f. Danzig, Germany, and that net and gross weights be carefully stated.

Russia's Trade with Germany.—The Russian German Messenger publishes the following statistics covering the imports into and the exports from European Russia (Finland not included) from and to Germany during the years 1900-1902 and the first two months of 1903:

Year.	Imports.		Exports.	
	Rubles.		Rubles.	
1900	...216,857,000	$111,681,355	187,635,000	$96,632,025
1901	...208,823,000	107,543,845	179,413,000	92,397,695
1902	...202,886,000	104,486,290	203,596,000	104,851,940
1903, 2m	31,819,000	16,386,785	28,441,000	14,647,145

Trade Opportunities Abroad.—Competition for Milk Separators in Russia.—The St. Petersburg Journal of July 4 announces that the Russian Department of Agriculture is instituting a competition for the best milk separators, which must be able to separate from 40 to 50 gallons per hour. The contest is open to both Russian and foreign manufacturers, and will take place next year at the Agricultural Museum, St. Petersburg. Two prizes—of $780 and $258, respectively—are offered. Entries must be made before February 15, 1904.

Agricultural Machinery and Hardware in the Soudan.—The British Board of Trade Journal of July 2 contains an article on the "Commercial development of the Egyptian Soudan," in which attention is directed to the various openings in that country. With the development of agriculture, it is pointed out that a demand for machinery is bound to arise, particularly as regards irrigation machinery, cotton gins, and oil and flour-milling machinery.

Brazilian Nuts for the United States.—The nut crop for this year, the season for which has just closed, was about the same as last year. This year, however, the United States has taken two-thirds of the product, of which Europe heretofore has taken the bulk. It is too early as yet to speak of the prospects for this season's crop.—K. K. Kenneday, Consul at Para.

American Coal in Para.—A very noteworthy feature of the commercial situation here is the fact that within the past few days three large sailing vessels have arrived laden with American coal.—K. K. Kenneday, Consul at Para.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. The other Reports can be obtained by applying to the Bureau of Trade Relations, Department of Commerce and Labor, Washington, D. C. Since the number of Reports is limited, application for those which are desired should be made immediately.

TRADE NOTES AND RECIPES.

The following fly paper formulæ are given in the Augsburg Seifensieder Zeitung:

1. Boil together for half an hour:

Ground quassia wood	18 pounds
Broken colocynth	3 pounds
Ground long pepper	5 pounds
Water	80 pounds

Then percolate and make up to 60 pounds if necessary with more water. Then add 4 pounds of syrup. Unsized paper is soaked in this, and dried as quickly as possible to prevent it from getting sour.

2. Mix together:

Ordinary syrup	100 ounces
Honey	30 ounces
Extract of quassia wood	4 ounces
Oil of aniseed	a few drops

In order to dye feathers, says the Druggists' Circular and Chemical Gazette, a prerequisite appears to be softening them, which is sometimes accomplished by soaking them in warm water, and sometimes an alkali such as ammonium or sodium carbonate is added. This latter method would apparently be preferable on account of the removal of any greasy matter that may be present.

When so prepared the feathers may be dyed by immersion in any dye liquor. An old-time recipe for black is immersion in a bath of ferric nitrate suitably diluted with water, and then in an infusion of equal parts of logwood and quercitron. Doubtless an anilin dye would prove equally efficient and would be less troublesome to use.

After dyeing, feathers are dipped in an emulsion formed by agitating any bland fixed oil with water containing a little potassium carbonate, and are then dried by gently swinging them in warm air. This operation gives the gloss.

Curling where required is effected by slightly warming the feathers before a fire and then stroking with a bluntt metallic edge, as the back of a knife.

A certain amount of manual dexterity is necessary to carry the whole process to a successful ending.

If soap and water are used for cleaning harness and other articles of leather, says the Druggists' Circular and Chemical Gazette, it is preferable to have a neutral soap so as to remove as little as possible of the oily matters with which the leather has been dressed, and on which it depends for continued softness. After cleansing of dirt, harness may be redressed with either of the following:

I.

Spirit of turpentine	8 ounces
Beeswax	2 ounces
Prussian blue	½ ounce
Lampblack	¼ ounce

Melt the wax in an iron ladle, add the turpentine, and then the finely powdered Prussian blue and lampblack, and thin with neatsfoot oil.

II.

Mutton suet	2 ounces
Beeswax	6 ounces
Lampblack	1 ounce
Spirit of turpentine	4 ounces
Water	4 ounces

To Sweeten Rancid Butter.—Although many recipes are given in the cookery books, the formularies, and the trade and agricultural journals, for making rancid butter again sweet and fresh, we have our doubts about any of them being entirely able to make palatable butter out of butter that has once become strongly rancidified. With this premise, we give all the information on the subject that we have at hand. One authority advises to wash the butter, first with fresh milk, and afterward with spring water, carefully working out the residual water. This, it seems to us, even if effective, will cost about as much time and material as to convert the milk into fresh butter. Another recipe says to add 25 to 30 drops of lime chloride to every 2 pounds of butter, work the mass up thoroughly, then wash in plenty of fresh, cold water, and work out the residual water. Another, and this seems based on sound principles, is to melt the butter in a water-bath, along with some freshly burned animal charcoal, coarsely powdered, and carefully sifted to free it from dust. Let remain in contact a few minutes, then strain off the butter through clean flannel. If not absolutely free from rancid odor and taste, repeat the process.—Nat. Drug.

How to Clean a Panama Hat.—For a great many years—more than a quarter of a century—the writer hereof has worn Panama hats exclusively in summer time. For at least ten years, when his hat needed cleaning he took it to a hatter who invariably wanted $2.50 for the job, explaining the enormity of the charge by telling him that there was only one concern in the United States, and that located in Boston, that could properly clean a Panama. One day, about eighteen years ago, an old and very dirty hat, used only on fishing trips, was subjected to a good scrubbing with castile soap and warm water, a nail-brush being used as an aid to get the dirt away. The hat was then placed in the hot sun to dry and in the course of two or three hours was ready for use. To his great astonishment, it was not only as clean as when new, but had retained its shape admirably, and looked so well that another old straw hat was used on the trip, and the Panama was reserved for wear in town. The cleaned hat was a trifle stiff at first, but soon grew supple under wear. Since that time we have never taken a Panama to a hatter, except on rare occasions, when it lost its shape in drying, and then only to have it pressed. Experimenting a little after the first scouring, we found that a little glycerin added to the rinsing water entirely prevented the stiffness and brittleness acquired by some hats in drying, while a little ammonia in the wash-water materially assisted in the scrubbing process. Ivory, or, in fact, any good white soap, will answer as well as castile for the purpose. It is well to rinse a second time, adding the glycerin to the water used the second time. Immerse the hat completely in the rinse water, moving it about to get rid of traces of the dirty water. When the hat has been thoroughly rinsed, press out the surplus water, using a Turkish bath towel for the purpose, and let it rest on the towel when drying.—Nat. Drug.

THE

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